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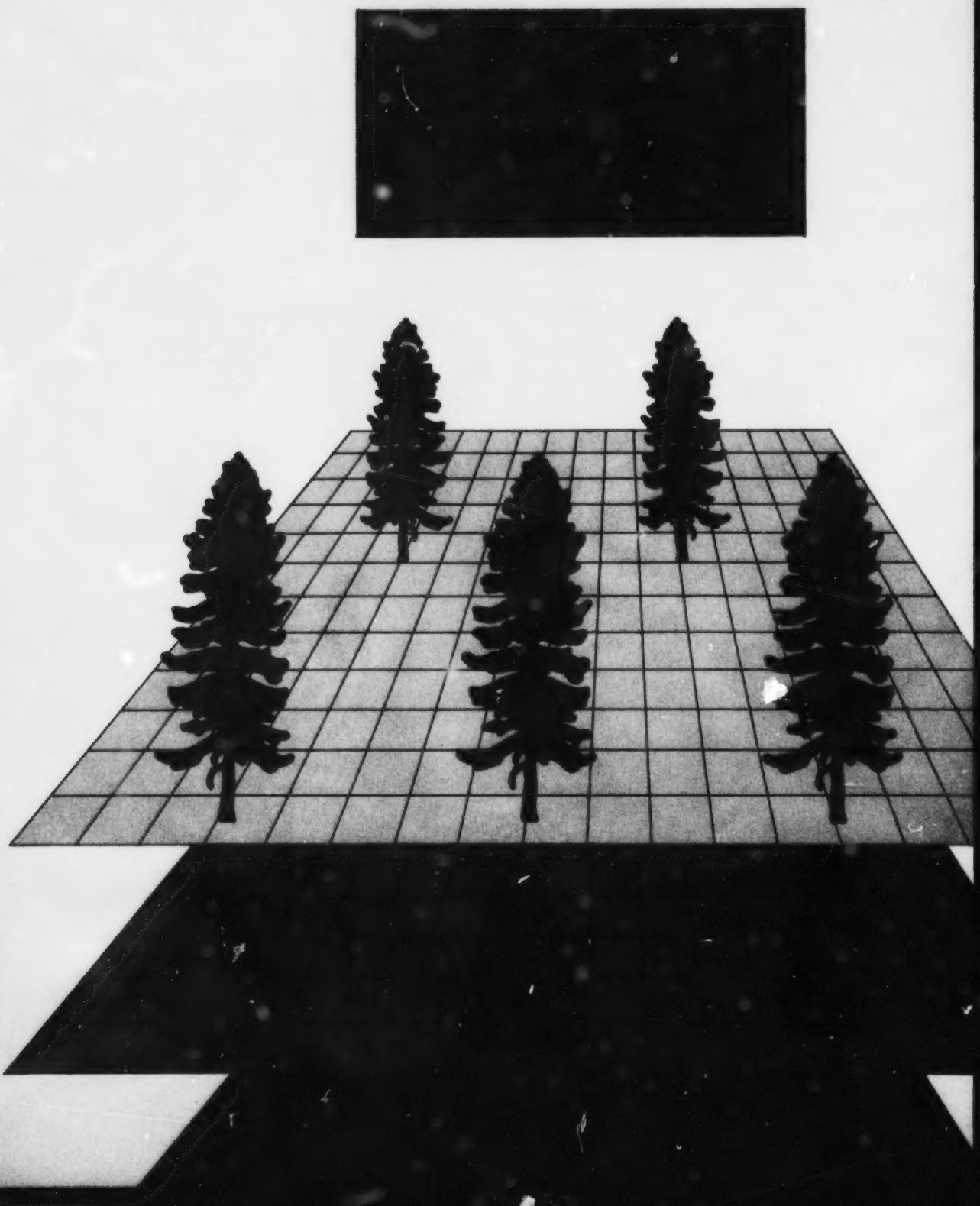

Vegetation Management Activities of Forestry Canada: A Compendium of Summaries 1988/89

Prepared by Forestry Canada's Vegetation Management Working Group

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with assistance and cooperation from other Forestry Canada personnel working on vegetation management.

Forestry Canada
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Introduction

The Vegetation Management Working Group of Forestry Canada was formally established by the Committee of Research Establishments in the spring of 1987. The working group consists of at least one appointed member from each regional establishment and national institute and a secretary from headquarters. It is expected that meetings will be held annually, or at such other times as may be warranted, and will be held in various parts of the country to facilitate appreciation of the forest vegetation management concerns as they differ in each region.

The mandate of the working group shall be "to promote sound methods of forest vegetation management in Canada." This will be accomplished by:

(i) defining vegetation management concerns on a regional basis and describing those with a national scope;

(ii) developing vegetation management guidelines and solutions to forest vegetation management problems;

(iii) developing and maintaining a working rapport with scientists in vegetation management-related research in Forestry Canada and regional agencies, in the fields of biocontrol, prescribed burning, herbicide application, planting stock production, and scarification techniques; and

(iv) advising Forestry Canada's management on vegetation management priorities and responding to policy and planning guidelines.

This working group has a broad field of endeavor and the members recognize the need to interact with other groups concerned with various aspects of reforestation silviculture. The working group will actively promote the coordination of research among Forestry Canada's establishments and provide advice to its research managers. The group will have a supportive role in Forestry Canada in the areas of development and coordination of vegetation management programs. Interactions within the peer review system and the ongoing program assessment are to be expected.

Current working group members are:

NeFC — Brian Titus
FC-M — Len Lanteigne
LFC — Claude Delisle
FPMI — Phil Reynolds
GLFC — Roy Sutton, Jim Wood, Fred von Althen
NoFC — Lorne Brace, Joe Feng, Surindar Sidhu
PFC — Ed Oswald (Chairman)
FC-HQ — J. Peter Hall (Secretary)

At the inaugural meeting of the working group held in Sault Ste. Marie in May 1988, it was decided that an overview of vegetation management work being done within Forestry Canada would be beneficial to gain an appreciation of our current status, to identify data gaps, and to formulate proposals for strengthening Forestry Canada's role in vegetation management. Summaries were prepared by each study leader according to an agreed format, scientifically edited by the regional working group member, sent to the chairman for editing and compiling, and then forwarded to the secretary for printing. The present document presents the summaries and includes a statement outlining the work being done by Forestry Canada. Publication of these summaries is expected to be an ongoing activity within Forestry Canada and will be expanded to include the work of other agencies in the future.

A list of common and scientific plant names is appended for reference purposes. Many of the fungi and bacteria do not have common names, so only the scientific names were used.

Project Summaries

Control of hardwood competition and release of softwood regeneration on a mixedwood cutover in western Newfoundland. Richardson, J.; Titus, B.D. ***Objective:*** To compare chemical and mechanical brushcutting techniques for the release of softwood regeneration on a highly productive mixedwood cutover. ***Location:*** South Brook valley, 25 km east of Corner Brook, western Newfoundland. ***Methods:*** **Site History** – Original stand of balsam fir and white birch was harvested (clearcut) for pulpwood in 1969. The experiment was established in 1977 in the middle of a moderately steep, east facing slope, at which time the site had regenerated to balsam fir, white birch, and pin cherry, with a ground vegetation of raspberry and fireweed. **Soils** – Fresh to moist stony loam (sand 42%, silt 35%, clay 23%). In 1977 the pH of combined A and upper B horizons was 5.0, OM content was 12%, and total nutrient concentrations of N, P, and K were 2 788, 710, and 6 625 ppm. **Application Specifications** – Five treatments: 2,4,5-T + 2,4-D (BRUSHKILL, amine formulation, with a.i. at 1.4 kg/ha in each of the compounds (thus 2.8 kg a.i. in total), in water at 700 L/ha, applied 5–6 July 1978); triclopyr (GARLON 3A, triethyl amine formulation, a.i. 1.9 kg/ha, in water at 700 L/ha, applied 6–7 July 1978); glyphosate (ROUNDUP, a.i. 2.25 kg/ha, in water at 400 L/ha, applied 28–29 August 1978); mechanical brushcutting with portable motorized brushcutters, applied 24–25 August 1978; and control. The three herbicides were applied with a motorized backpack mist blower. **Experimental Design** – Treatment plots (25 × 40 m) were randomized and replicated four times; 15 permanent vegetation quadrats (2 × 2 m) were established end-on-end along a randomly located transect in each plot. **Measurements Taken** – Softwood height and leader length, hardwood height, stem density, and ground vegetation were recorded in 1977 (pre-treatment), July 1979 (1 year post-treatment), August 1980 (2 years post-treatment), and 1984 (6 years post-treatment). ***Results:*** At 1 year post-treatment, glyphosate caused the only statistically significant reduction in hardwood stem density (70%), followed by 2,4,5-T + 2,4-D (60%) and triclopyr (26%), while brushcutting caused a statistically significant increase in stem density (245%). Two-year results were similar. Total, relative, and percentage softwood height and leader length increased with herbicide treatments, but the differences were not statistically significant. The lack of significance is attributed to pre-treatment variation in fir height. Six-year data are being analyzed at present, and future remeasurements are envisaged. ***Conclusion:*** Chemical treatments were successful in reducing hardwood competition, while brushcutting ultimately increased hardwood stem density over the first 2 years. No treatments resulted in significantly increased softwood height growth. **(NEWFOUNDLAND FORESTRY CENTRE, St. John's, Newfoundland.)**

References: Richardson, J. 1980. Mechanical and chemical treatment of hardwood competition in mixedwood cutovers in western Newfoundland. Inf. Rep. N-X-188. 16 pp.

Richardson, J. 1984. Control of hardwood competition and release of softwood regeneration on a mixedwood cutover in western Newfoundland. Inf. Rep. N-X-225. 23 pp.

Release of young spruce and pine from alder competition. Richardson, J.; Titus, B.D. ***Objective:*** To compare chemical and mechanical brushcutting techniques for the release of softwood regeneration overtopped by alders. ***Location:*** North Pond experimental area, 32 km south of Gander, Newfoundland. ***Methods:*** **Site History** – The original mature black spruce and balsam fir forest was burned in 1941 and 1961. The area was seeded by helicopter in 1965 with black spruce and jack pine, and in 1970 was 85% and 59% stocked to black spruce and jack pine at densities of 18 800 and 4 000 stems/hectare, respectively. Alders rapidly overtopped the softwoods. The experiment was laid out in the spring of 1975. **Application Specifications** – Five treatments: 2,4-D (applied 8–9 July 1975, a.i. acid equivalent of the amine formulation at 1.1 kg/ha, in water at 400 L/ha, using a backpack mist blower); 2,4-D at the same rate but applied 6–7 August 1975; picloram (TORDON 10K with a.i. at 4 kg/ha as pellets, by hand); brushcutting in August–October 1975 using motorized brushcutters and axes; and control. **Experimental Design** – Treatment plots (50 × 40 m) were randomized in four replicates. Two subplots (10 × 10 m) were randomly located within each treatment plot, and subdivided into 25 permanent quadrats (2 × 2 m). **Measurements Taken** – Pre-treatment surveys were conducted in spring of 1975, and post-treatment surveys in May 1976, August 1976 (1–year), August–September 1977 (2-year), September 1979 (4-year), and September–November 1984 (9-year). ***Results:*** Two years after treatment, hardwood cover was significantly reduced with all treatments except early application of 2,4-D. No statistically significant effect occurred on softwood height or leader length 2 years after treatments and there was no significant effect on stocking or density of spruce and pine. Picloram had a noticeably negative effect on jack pine stocking and density. Brushcutting increased hardwood stem densities by 25%, and hardwood sprouting was least on picloram plots (only 27% of original density). At 4 years there were still no statistically significant treatment effects, but trends were apparent. Picloram had the largest negative influence on spruce and pine stocking and density; pines were especially sensitive to damage. The lack of treatment effect is attributed to large variations in pre-treatment conditions. Increased softwood growth was most pronounced where hardwoods were more than twice as tall as softwoods before treatment, suggesting that alders do not pose a serious threat unless competition is a major problem. Perhaps a trade-off between increased alder competition for growth-limiting resources and increased soil fertility through N-fixation may account for the reduction in alder competition yet lack of significant softwood response. Future studies on this site utilizing stem volume are envisaged. Also, an alder interplanting experiment on another site utilizing a range of alder densities has been initiated to investigate under more controlled conditions the interaction between alders and softwoods. ***Conclusion:*** Chemical methods were better at controlling hardwood growth than mechanical methods. There was no demonstrable increase in softwood growth, attributed to possible beneficial effects of alders on soil fertility. **(NEWFOUNDLAND FORESTRY CENTRE, St. John's, Newfoundland.)**

References: Richardson, J. 1979. Releasing softwood regeneration from overtopping alders. Inf. Rep. N-X-169. 24 pp.

Richardson, J. 1982. Release of young spruce and pine from alder competition. Inf. Rep. N-X-211. 13 pp.

Establishment of softwoods on sites dominated by sheep-laurel. Titus, B.D.; Meades, W.; Roberts, B.A. ***Objective:*** To successfully establish softwoods (spruce, pine, or larch) on sites heavily dominated by sheep-laurel. ***Location:*** Northern Arm Brook valley, 6.5 km west of Botwood, central Newfoundland. ***Methods:*** **Site History** – The previous stand of 65–70 year old black spruce was commercially thinned in 1973–74, burnt in a wildfire in 1979, and salvage-cut in 1982. The site is now heavily dominated by sheep-laurel, a species thought to allelopathically inhibit black spruce growth. **Soils** – Coarse, well drained, on a kame terrace. **Experimental Design** – A large trial was laid out in 1987 to test a combination of treatments to be applied over the next 2 years using a full factorial split plot design replicated four times.

Treatment	*Number*	*Description*	*Date*
Scarification	2	(control, TTS disc trencher)	1989
Herbicide	2	(control, triclopyr + hexazinone)	1989
Fertilizer	3	(control, N, NPK)	1990
Species	3	(black spruce, jack pine, European larch)	1990

There are a total of 2 × 2 × 3 × 3 = 36 treatments. Site preparation (scarification +/– herbicide +/– fertilizer) treatment plots are 30 × 30 m, with 5-m buffer strips separating plots. Each replicate was split and randomized for application of the disc trenching. The factorial herbicide and fertilizer treatments were then randomly assigned, as methods allow greater mobility for application of these two treatments. The 30 × 30 m site-preparation treatment plots were subdivided for the three species treatments (30 × 10 m each). In 1990, 150 seedlings will be planted in each treatment at a 1 × 2 m spacing, to allow for destructive sampling. **Planned Measurements** – Seedling response (height, root collar diameter, biomass, nutrient content, and concentration) will be measured after one, two, three, and five growing seasons. Sheep-laurel response will be determined from permanent plots. Organic matter will be sampled for nutrient capital and availability, and field decomposition rate. ***Results:*** Initial silvicultural prescription recommendations will be made at the end of 3 years, and these will be updated at the end of 5 years. ***Additional Comments:*** The field trial is a cooperative venture among all forestry agencies in the province. All treatments are ones that are or could be made operationally viable in Newfoundland, with the exception of the herbicide treatment, where the aim is to ensure that sheep-laurel is killed rather than merely "knocked back." If this treatment is successful, specifically designed herbicide field trials will have to follow. Initial observations from operational sprays suggest that glyphosate may be effective in partially or totally killing sheep-laurel, and it is envisaged that an experimental design incorporating dosage × surfactant × time of application treatments over a range of sites of varying productivity will ultimately be appropriate. **(NEWFOUNDLAND FORESTRY CENTRE, NEWFOUNDLAND DEPARTMENT OF FORESTRY, ABITIBI-PRICE, and CORNER BROOK PULP AND PAPER LTD., St. John's, Newfoundland.)**

References: Titus, B.D.; Meades, W. 1988. Proposal for the establishment of an integrated and collaborative field trial and demonstration of methods of *Kalmia* control and subsequent softwood response. CFS-NeFC File Report 108.

The impact of cleaning with herbicide on successional development and the growth of balsam fir after clearcutting a fir-spruce forest. Lanteigne, L.J. 1984. (M.Sc.F. Thesis, University of New Brunswick). ***Objectives:*** To determine the effects of clearcutting and subsequent cleaning with herbicide on community structure and functional processes; to determine the growth response of balsam fir to cleaning with herbicide. ***Location:*** Maritime uplands ecoregion, New Brunswick. ***Methods:*** **Site History** – Mixedwood stand, harvested in 1962. Clearcutting resulted in abundant regeneration, particularly of pioneer species, such as pin cherry and red raspberry. **Soils** – Surficial deposits of glacial basal till and minor ablation till, resulting in fertile stony loams and silt loams with a depth of 0.5 m and a Ferro-Humic Podzol development. **Application Specifications** – In July 1974, a low volatile ester of Brushkill 76 (2,4-D and 2,4,5-T mixture) was applied aerially at an ingredient rate of 9.3 L/ha in water. **Experimental Design** – In 1983, 1-ha blocks were established with perpendicular transect lines, and 25 intersection points were randomly selected for midpoints of sample plots. **Measurements Taken** – Annual height increments, age determination, diameter, basal area, and volume growth. ***Results:*** Cleaning with herbicide resulted in an immediate and significant growth increase by the suppressed understory balsam fir, with no shock effect or lag time in growth response. Cleaning increased height growth by 9–34%, diameter growth by 28–46%, basal area growth by 49–120%, and volume growth by 142–257%. However, there was a rapid shift from interspecies competition to intraspecies competition amongst balsam fir stems, due to extremely high density. Specific volume increment displayed great sensitivity to this density-dependent relationship of intraspecies competition. ***Conclusion:*** The ability of balsam fir to maintain population levels beneath the dense hardwood canopy, the immediate growth response to release, the short life-span of pin cherry, and the maintenance of subordinate plant species diversity indicate that herbicide treatment does not alter the direction of community development after disturbance, but rather the rate of this development. **(FORESTRY CANADA – MARITIMES, Fredericton, New Brunswick.)**

Effects of pre-emergence herbicides on weed control and the growth of r1 + 0 black spruce and jack pine seedlings. Lanteigne, L.J.; Burns, T.W.; Hallett, R.D. 1985. (Expert Committee on Weeds – Eastern Section). ***Objectives:*** To study the effect of various pre-emergence herbicides on grass and broadleaf weeds and on germination and growth of r1 + 0 black spruce and jack pine seedlings. ***Location:*** J.D. Irving's Forest Nursery, Juniper, New Brunswick. ***Methods:*** **Growth Medium** – Bareroot seedbed of well drained loamy sand . **Application Specifications** – A Research and Development sprayer equipped with pressurized CO_2 and LP8003 nozzles was used. Total spray volume was 236 L/ha at 207 kPa. Treatments were applied prior to germination of both weeds and conifer seedlings. **Experimental Design** – Randomized block with three replications. Treatment plots were 1.3 m wide by 3 m long. **Measurements Taken** – Weeds were classified as grass or broadleaf, counted, and removed from the plots twice during the growing season. Height, root collar diameter, and dry weight were measured for 30 seedlings randomly selected from each treatment. ***Results:*** The only treatments that significantly affected germination were napropamide (increase: + 40%) and propazine (decrease: – 15%) for black spruce. There was no significant effect on jack pine germination. There was no significant herbicide effect on seedling growth of black spruce or jack pine at the completion of one growing season.

Herbicide a.i. (kg/ha)	*Percent Control*	
	Grass	*Broadleaf*
Bifenox (1.12)	82	65
Oxyfluorfen (0.28)	94	76
Prometryn (1.12)	72	77
Napropamide (2.24)	95	58
Propazine (1.12)	92	95
DCPA (6.72)	44	10
Napropamide + oxyfluorfen	100	92
Prometryn + DCPA	86	81
Control	—	—

Conclusions: Propazine (a.i. 1.12 kg/ha) may significantly reduce germination of black spruce. Use of DCPA (a.i. 6.72 kg/ha) does not provide satisfactory control of grass and broadleaf weeds. **(FORESTRY CANADA – MARITIMES, Fredericton, New Brunswick.)**

Effects of sethoxydim, fluazifop-butyl, and oxyfluorfen on weed control and black spruce container seedlings. Lanteigne, L.J.; Burns, T.W.; Hallett, R.D. 1985. (Expert Committee on Weeds – Eastern Section). ***Objectives:*** To study the effect of sethoxydim, fluazifop-butyl, and oxyfluorfen on major weed species and on black spruce seedlings. ***Location:*** Department of Natural Resources' Forest Nursery, Kingsclear. New Brunswick. ***Methods:*** **Site History** – Black spruce was seeded in May 1985 in multipots containing a growing medium of spaghnum peat moss and vermiculite. The seedlings were grown in an open holding area. Prior to herbicide testing, 12 weed species were present with a 30–39% cover. The major weed species were aspen poplar and rush and grass species. **Application Specifications** – A Research and Development sprayer equipped with pressurized CO_2 and LP8003 nozzles was used. Total spray volume was 486 L/ha at 207 kPa. The following herbicides and rates were applied on July 30, 1985: sethoxydim, fluazifop-butyl, and oxyfluorfen with a.i. at 0.28, 0.56, and 1.12 kg/ha. There was no rainfall during application or within 48 hours following application. **Experimental Design** – Split-plot randomized block design with five replications. **Measurements Taken** – Qualitative evaluation of both weed control and seedling damage was conducted. ***Results:*** There was slight needle burn to the uppermost needles of the black spruce seedlings from oxyfluorfen at a.i. of 1.12 kg/ha. The apical meristem was not damaged and seedlings recovered rapidly. Oxyfluorfen provided 50–79% control of aspen poplar with no significant relationship between rate and control. Sethoxydim and fluazifop-butyl had no effect on rush. Oxyfluorfen provided 60–100% control of rush, with a direct relationship between rate and control. Sethoxydim and fluazifop-butyl provided 20–79% control of grass, with a direct relationship between rate and control. ***Conclusions:*** Operational rates of oxyfluorfen (a.i. at < 0.56 kg/ha) can provide satisfactory control of aspen poplar and rush species without severe damage to black spruce seedlings. Sethoxydim and fluazifop-butyl at a.i. of 1.12 kg/ha will provide satisfactory control of grass species without damage to black spruce seedlings. **(FORESTRY CANADA – MARITIMES, Fredericton, New Brunswick.)**

Effects of various pre-emergence herbicides on germination and growth of jack pine seedlings within a bareroot seedbed. Lanteigne, L.J.; Burns, T.W.; Hallett, R.D. 1986. (Expert Committee on Weeds – Eastern Section). ***Objectives:*** To study the effect of various pre-emergence herbicides on germination and growth of jack pine bareroot seedlings. ***Location:*** J.D. Irving's Forest Nursery, Juniper, New Brunswick. ***Methods:*** **Site History** – Seedbed was prepared in the fall of 1983. Seeding density was 68 seeds per 0.1 m^2 with an objective of 25 seedlings per 0.1 m^2 at r2 + 0. Seedlings were not germinated at time of herbicide application. **Soils** – Loamy sand. **Application Specifications** – Treatments were applied on June 4, 1984, with a Research and Development sprayer equipped with pressurized CO_2 and LP8003 nozzles. Total spray volume was 486 L/ha at 138 kPa. **Experimental Design** – Stratified random block with three replications. Three subplots were located within each treatment plot to determine seedling density. **Measurements Taken** – Seedling counts were conducted in July and August 1984. Height, root collar diameter, and dry weight for 30 randomly selected seedlings from each treatment were taken in fall 1984 (r1 + 0) and fall 1985 (r2 + 0). Data for height and root collar diameter were subjected to variance analysis and means were separated using Duncan's multiple-range test ($P = 0.05$). Data for dry weight were subjected to non-parametric statistics (linear ranking) and variance analysis was performed on ranked score ($P = 0.05$). ***Results:***

Treatment	Rate of a.i. (kg/ha)	No. of seedlings per 0.1 m^2	r1 + 0 Height (cm)	r1 + 0 Dry weight (g)	r2 + 0 Height (cm)	r2 + 0 Dry weight (g)
Bifenox	1.12	42	5.7	0.48	21.0	2.84
Oxyfluorfen	0.28	42	5.4	0.47	22.1	2.79
Prometryn	1.12	42	5.0	0.44	19.5*	2.20*
Napropamide	2.24	41	5.1	0.37	20.8	3.43
Propazine	1.12	41	5.0	0.38	18.9*	2.72
DCPA	6.72	49	5.4	0.44	20.0	2.66
Napropamid/ oxyfluorfen	2.24/ 0.28	48	5.0	0.41	20.4	2.58
Prometryn/ DCPA	1.12/ 6.72	43	5.0	0.40	19.9*	2.45*
Control		50	5.5	0.48	22.7	3.82

*Significantly different from control ($P = 0.05$)

Conclusions: All the herbicide treatments decreased jack pine germination but the decrease was not significant. Propazine and prometryn can cause a significant decrease in growth (r2 + 0) of jack pine seedlings. **(FORESTRY CANADA – MARITIMES, Fredericton, New Brunswick.)**

Effects of various pre-emergence herbicides on germination and growth of black spruce seedlings within a bareroot seedbed. Lanteigne, L.J.; Burns, T.W.; Hallett, R.D. 1986. (Expert Committee on Weeds – Eastern Section). ***Objectives:*** To study the effect of various pre-emergence herbicides on germination and growth of black spruce bareroot seedlings. ***Location:*** J.D. Irving's Forest Nursery, Juniper, New Brunswick. ***Methods:*** **Site History** – Seedbed was prepared in the fall of 1983. Seeding density was 460 seeds per 0.1 m^2, with an objective of 125 seedlings per 0.1 m^2 at r2+0. The seeds had not germinated at time of herbicide application. **Soils** – Loamy sand. **Application Specifications** – Treatments were applied on June 4, 1984, with a Research and Development sprayer equipped with pressurized CO_2 and LP8003 nozzles. Total spray volume was 486 L/ha at 138 kPa. **Experimental Design** – Stratified random block with three replications. Three subplots were located within each treatment plot to determine seedling density. **Measurements Taken** – Seedling counts were conducted in July and August 1984. Height, root collar diameter, and dry weight for 30 randomly selected seedlings from each treatment were taken in fall 1984 (r1+0) and fall 1985 (r2+0). Data for height and root collar diameter were subjected to variance analysis and means were separated using Duncan's multiple-range test ($P = 0.05$). Data for dry weight were subjected to non-parametric statistics (linear ranking) and variance analysis was performed on ranked score ($P = 0.05$). ***Results:***

Treatment	Rate of a.i. (kg/ha)	No. of seedlings per 0.1 m^2	r1 + 0 Height (cm)	r1 + 0 Dry weight (g)	r2 + 0 Height (cm)	r2 + 0 Dry weight (g)
Bifenox	1.12	145	3.3	0.08	17.3	0.66
Oxyfluorfen	0.28	162	3.6	0.07	16.2	0.62
Prometryn	1.12	140	3.3	0.06	15.2*	0.54*
Napropamide	2.24	186*	3.2	0.07	17.0	0.63
Propazine	1.12	114	3.1	0.06	14.3*	0.69
DCPA	6.72	142	3.5	0.07	15.6	0.64
Napropamide/ oxyfluorfen	2.24/ 0.28	163	3.7	0.08	16.3	0.66
Prometryn/ DCPA	1.12/ 6.72	154	3.2	0.07	16.6	0.67
Control	—	133	3.6	0.08	17.4	0.65

*Significantly different from control ($P = 0.05$).

Conclusions: Napropamide can result in a significant increase in black spruce germination. Propazine and prometryn can result in decreased seedling growth of black spruce during both the first (r1+0) and second (r2+0) growing seasons. **(FORESTRY CANADA – MARITIMES, Fredericton, New Brunswick.)**

Effect of sethoxydim, fluazifop-butyl, and oxyfluorfen on control of rye grass. Lanteigne, L.J.; Burns, T.W.; Hallett, R.D. 1986. (Expert Committee on Weeds – Eastern Section). ***Objectives:*** To study the effect of total spray volume, additives, and tank mixes of sethoxydim, fluazifop-butyl, and oxyfluorfen on rye grass. ***Location:*** Department of Natural Resources' Forest Nursery, Kingsclear, New Brunswick. ***Methods:*** **Site History** – Rye grass was seeded as a fallow crop in fall 1985. Treatments were applied on May 6, 1986, when the rye grass was at the 3–5 leaf stage, and 5–10 cm in height. **Soils** – Sandy loam. **Application Specifications** – A Research and Development sprayer equipped with pressurized CO_2 was utilized. Herbicides tested were sethoxydim, fluazifop-butyl, and oxyfluorfen at a.i. of 0.5 kg/ha. Total spray volumes were 121 L/ha (L80015 nozzles at 140 kPa), 243 L/ha (LP8003 nozzles at 140 kPa), and 486 L/ha (LP8003 nozzles at 140 kPa). There was no rainfall within 48 hours following treatment application. **Experimental Design** – Randomized block. **Measurements Taken** – Qualitative visual estimates of treatment effect. ***Results:*** There was no difference between the three spray volumes and the control of rye grass for either sethoxydim or fluazifop-butyl. The addition of assist oil (1.5% of total spray volume) to sethoxydim and Agral 90 (0.1% of total spray volume) to fluazifop-butyl slightly increased herbicidal effect. The addition of oxyfluorfen in a tank mix with sethoxydim or with fluazifop-butyl decreased the herbicidal effect. Oxyfluorfen caused necrosis of the leaves, thereby decreasing translocation of sethoxydim or fluazifop-butyl to the roots for complete control of the plant. ***Conclusion:*** Application of sethoxydim and fluazifop-butyl resulted in similar control of rye grass, regardless of total spray volume. Addition of adjuvants increased control effectiveness; addition of oxyfluorfen decreased control effectiveness. **(FORESTRY CANADA – MARITIMES, Fredericton, New Brunswick.)**

Effect of napropamide and oxyfluorfen on the growth of black spruce bareroot seedlings. Lanteigne, L.J.; Burns, T.W.; Hallett, R.D. 1986. (Expert Committee on Weeds – Eastern Section). ***Objectives:*** To study the effect of napropamide and oxyfluorfen on the growth of black spruce bareroot seedlings. ***Location:*** J.D. Irving's Forest Nursery, Juniper, New Brunswick. ***Methods:*** **Site History** – Seed bed was prepared in fall 1982. Seedlings grew in the seedbed during 1983 and 1984. Seedlings were transplanted in spring 1985. Treatments were applied July 1985 when the seedlings were actively growing. **Soils** – Loamy sand. **Application Specifications** – Treatments were applied with a Research and Development sprayer equipped with pressurized CO_2 and LP8003 nozzles. Total spray volume was 486 L/ha at 138 kPa. **Experimental Design** – Randomized block with five replications. Sample plots were 1.3 m in width and 3 m in length. **Measurements Taken** – Height, root collar diameter, and dry weight were recorded for 50 randomly selected seedlings per treatment. Data were subjected to variance analysis and, where differences were indicated, means were separated by Student-Newman-Keul's multiple range test ($P = 0.05$). ***Results:*** There was no significant difference between treatments for height, root collar diameter, and dry weight. ***Conclusion:*** Napropamide and oxyfluorfen, applied over actively growing black spruce (r2 + 1) seedlings, will not significantly reduce growth. **(FORESTRY CANADA – MARITIMES, Fredericton, New Brunswick.)**

Effect of various pre-emergence herbicides on grass and broadleaf weeds. Lanteigne, L.J.; Burns, T.W.; Hallett, R.D. 1986. (Expert Committee on Weeds – Eastern Section). ***Objectives:*** To study the effect of bifenox, oxyfluorfen, prometryn, napropamide, propazine, and DCPA on grass and broadleaf weeds. ***Location:*** J.D. Irving's Forest Nursery, Juniper, New Brunswick. ***Methods:*** **Site History** – Seedbeds were prepared in fall 1983. Herbicides were applied June 4, 1984, prior to emergence of weeds. **Soils** – Loamy sand. **Application Specifications** – A Research and Development sprayer equipped with pressurized CO_2 and LP8003 nozzles was used. Total spray volume was 486 L/ha at 138 kPa. There was no rainfall within 48 hours following treatment application. **Experimental Design** – Stratified random block with three replications on two sites. **Measurements Taken** – Grass and broadleaf weeds were counted and removed from the treatment plots periodically during the growing season. Data were subjected to nonparametric statistics (linear ranking) and variance analysis was performed on ranked scores ($P = 0.05$). ***Results:***

Treatment	*Rate of a.i.* (kg/ha)	*Percent Control*	
		Grass	*Broadleaf*
Bifenox	1.12	82	65
Oxyfluorfen	0.28	94	76
Prometryn	1.12	72	77
Napropamide	2.24	95	58*
Propazine	1.12	92	95
DCPA	6.72	44*	10*
Napropamide/oxyfluorfen	2.24/0.28	100	92
Prometryn/DCPA	1.12/6.72	86	81

*Significantly different from control ($P = 0.05$).

Conclusions: All herbicides tested, except for DCPA, provided satisfactory control of grass and broadleaf species. Oxyfluorfen, napropamide, and propazine provided the best grass control. Propazine and napropamide + oxyfluorfen provided the best broadleaf control. **(FORESTRY CANADA – MARITIMES, Fredericton, New Brunswick.)**

Effect of oxyfluorfen, napropamide, DCPA, and prometryn on germination and growth of white spruce bareroot seedlings and on weed control. Lanteigne, L.J.; Burns, T.W.; Hallett, R.D. 1986. (Expert Committee on Weeds – Eastern Section). ***Objectives:*** To study the effect of oxyfluorfen, napropamide, DCPA, and prometryn on germination and growth of white spruce bareroot seedlings and on grass and broadleaf weeds. ***Location:*** J.D. Irving's Forest Nursery, Juniper, New Brunswick. ***Methods:*** **Site History** – Seedbeds were prepared in fall 1984. Treatments were applied November 1984 and a second application (booster) was made August 14, 1985, when the seedling roots were 6–8 cm in length. **Soils** – Loamy sand. **Application Specifications** – A Research and Development sprayer equipped with pressurized CO_2 and LP8003 nozzles was used. Total spray volume was 355 L/ha at 200 kPa. **Experimental Design** – Randomized block with three replications. **Measurements Taken** – Height, root collar diameter, and dry weight for 30 randomly selected seedlings per treatment were recorded at the end of the growing season. Germination counts were based on three 0.1-m^2 subplots with each treatment plot. Data were subjected to variance analysis and means were separated using Student-Newman-Keuls multiple-range test ($P = 0.05$). ***Results:*** None of the herbicide treatments had significant effect on germination, height, root collar diameter, or dry weight.

Treatment	*Rate of a.i.* (kg/ha)	*Percent Control*	
		Grass	*Broadleaf*
Control	6.72	—	—
DCPA	6.72	0	12
DCPA	2.24	0	0
Napropamide	2.24	100	67
Napropamide (booster)	2.24	100	54
Oxyfluorfen	0.28	100	62
Oxyfluorfen (booster)	0.28	100	58
Oxyfluorfen/DCPA	0.28/6.72	100	54
Oxyfluorfen/DCPA	0.28/6.72	100	67
Oxyfluorfen/napropamide	0.28/2.24	100	88
Oxyfl./napropamide (booster)	0.28/2.24	100	92
Oxyfluorfen/prometryn	0.28/1.12	96	62
Oxyfl./prometryn (booster)	0.28/1.12	100	92
Prometryn	1.12	53	67
Prometryn (booster)	1.12	79	67
Prometryn/DCPA	1.12/6.72	42	50
Prometryn/DCPA (booster)	1.12/6.72	40	71

Conclusions: DCPA, napropamide, oxyfluorfen, and prometryn are not detrimental to germination and growth of white spruce seedlings when applied prior to germination and over actively growing seedlings. DCPA and prometryn provided unsatisfactory grass control. Oxyfluorfen + napropamide and oxyfluorfen + prometryn provided the best broadleaf control. **(FORESTRY CANADA – MARITIMES, Fredericton, New Brunswick.)**

Effect of oxadiazon on the growth of black spruce container seedlings. Lanteigne, L.J.; Burns, T.W.; Hallett, R.D. 1987. (Expert Committee on Weeds – Eastern Section). ***Objectives:*** To study the tolerance of 5-month-old black spruce container seedlings to oxadiazon at a.i. of 3.8 kg /ha. ***Location:*** Department of Natural Resources' Forest Nursery, Kingsclear, New Brunswick. ***Methods:*** **Site History** – Black spruce was seeded in early July 1985 and grown in greenhouses. The seedlings developed buds in early November 1985 and were placed outdoors in late November 1985. **Application Specifications** – Oxadiazon (Ronstar, G 2%, May and Baker) at a.i. of 3.8 kg/ha was applied operationally with a motorized Gandy spreader. **Experimental Design** – Seven holding areas were included. Five replicates of paired treatments (control-oxadiazon) were randomly located within each holding area. **Measurements Taken** – In October 1986, five seedlings per replicate (25 per treatment) were randomly selected for morphological measurements. Height (0.1 cm) and root collar diameter (0.01 mm) were measured. Data were subjected to a *t*-test ($P = 0.05$). Oven-dry weight (0.01 g) for tops and roots (five trees per replicate grouped) was recorded. Data were subjected to non-parametric statistics (linear ranking) and a *t*-test was performed on ranked scores ($P = 0.05$). ***Results:*** There was no significant reduction in height, root collar diameter, or dry weight which could be attributed to oxadiazon. ***Conclusion:*** Oxadiazon at a.i. of 3.8 kg/ha applied at dormancy did not affect growth of 5-month-old black spruce container seedlings. **(FORESTRY CANADA – MARITIMES, Fredericton, New Brunswick.)**

Effect of various herbicides on the growth of black spruce container seedlings. Lanteigne, L.J.; Burns, T.W.; Hallett, R.D. 1987. (Expert Committee on Weeds – Eastern Section). ***Objective:*** To study the effect of oxyfluorfen, napropamide, trifluralin, DCPA, oxadiazon, and glyphosate on the growth of 5-month-old black spruce seedlings. ***Location:*** Department of Natural Resources' Forest Nursery, Kingsclear, New Brunswick. ***Methods:*** **Site History** – Black spruce was seeded in early July 1985 and grown in greenhouses. The seedlings developed buds in early November 1985 and were placed outdoors in late November 1985. Seedlings were dormant at the time of herbicide application. **Application Specifications** – Herbicide treatment included oxyfluorfen, a.i. 0.25, 0.5, 1.0 kg/ha; napropamide, a.i. 2.2, 4.4 kg/ha; trifluralin, a.i. 1.4, 2.8 kg /ha; DCPA, a.i. 5.0, 10.0 kg/ha; oxadiazon, a.i. 1.1, 2.2 kg/ha; and glyphosate, a.i. 0.42, 0.84 kg/ha. Emulsifiable concentrate formulations were applied with a CO_2 pressurized sprayer fitted with LP8003 nozzles delivering a total spray volume of 486 L/ha at an operating pressure of 138 kPa. Granular formulations were applied manually. **Experimental Design** – Randomized complete block with five replications. **Measurements Taken** – In October 1986, five seedlings per replicate (25 per treatment) were randomly selected for morphological measurements. Height, root collar diameter, and dry weight were measured. Data were subjected to variance analysis and means were separated using Student-Newman-Keul's multiple-range test ($P = 0.05$). ***Results:***

Treatment	*Rate of a.i.* (kg/ha)	*Height** (cm)	*Root collar diameter** (mm)	*Dry weight** (g)	
				Top	*Root*
Control	—	21.7^{abc}	2.8^{a}	6.34^{a}	0.99^{a}
DCPA	5.0	22.6^{abc}	2.6^{a}	5.65^{a}	0.90^{a}
DCPA	10.0	23.5^{abc}	2.8^{a}	6.49^{a}	1.05^{a}
Glyphosate	0.42	21.3^{abc}	2.7^{a}	5.90^{a}	1.06^{a}
Glyphosate	0.84	18.8^{d}	2.9^{a}	6.66^{a}	1.10^{a}
Napropamide	2.2	24.6^{a}	2.6^{a}	6.66^{a}	0.91^{a}
Napropamide	4.4	23.9^{ab}	2.7^{a}	7.05^{a}	1.04^{a}
Oxadiazon	1.1	22.0^{abc}	2.5^{a}	5.65^{a}	0.85^{a}
Oxadiazon	2.2	22.7^{abc}	2.5^{a}	5.95^{a}	0.90^{a}
Oxyfluorfen	0.25	22.8^{abc}	2.5^{a}	5.49^{a}	0.85^{a}
Oxyfluorfen	0.5	22.9^{abc}	2.6^{a}	6.70^{a}	0.98^{a}
Oxyfluorfen	1.0	23.0^{abc}	2.7^{a}	5.81^{a}	0.91^{a}
Trifluralin	1.4	22.8^{abc}	2.8^{a}	6.23^{a}	1.06^{a}
Trifluralin	2.8	20.5^{cd}	2.7^{a}	5.90^{a}	1.11^{a}

*Means with similar superscript letters are not significantly different ($P = 0.05$).

Conclusions: The only treatment that resulted in significant decrease in growth was glyphosate, at a.i. of 0.84 kg/ha. Additional research is required on the effect of glyphosate on conifer seedlings grown in sphagnum peat moss. **(FORESTRY CANADA – MARITIMES, Fredericton, New Brunswick.)**

Post-emergence applications of oxyfluorfen and sethoxydim on 12-week-old black spruce and white spruce container seedlings. Lanteigne, L.J.; Burns, T.W.; Hallett, R.D. 1987. (Expert Committee on Weeds – Eastern Section). ***Objectives:*** To study the effect of oxyfluorfen and sethoxydim on 12-week-old black spruce and white spruce container seedlings. ***Location:*** Fraser Forest Nursery, Edmundston, New Brunswick. ***Methods:*** **Site History** – Black spruce and white spruce were seeded April 25, 1986, and emerged May 9, 1986. Herbicides were applied 12 weeks post-emergence, when the seedlings were 3–5 cm in height and actively growing. **Growing Medium** – Sphagnum peat moss and vermiculite. **Application Specifications** – Treatments were applied with a pressurized CO_2 sprayer equipped with LP8003 nozzles delivering a total spray volume of 486 L/ha at an operating pressure of 138 kPa. No rainfall was recorded within 48 hours of treatment. **Experimental Design** – Randomized complete block with five replications. **Measurements Taken** – On October 6, 1987, five seedlings per replicate (25 per treatment) were randomly selected for morphological measurements. Height (0.1 cm) and root collar diameter (0.1 mm) were measured. Data were subjected to variance analysis and means were separated using Student-Newman-Keul's multiple-range test ($P = 0.05$). Oven-dry weight for tops and roots (five trees per replicate grouped) was recorded. Data were subjected to nonparametric statistics (linear ranking) and variance analysis was performed on ranked scores ($P = 0.05$). ***Results:*** A qualitative evaluation of seedlings 1 week following herbicide application indicated that there was no damage on the white spruce seedlings treated with oxyfluorfen at a.i. rates of 0.25 and 0.5 kg/ha but there was slight to moderate needle burn at 1.0 kg/ha. There was no damage from the 0.25-kg/ha a.i. rate on black spruce but there was slight needle burn at 0.5-kg/ha a.i. rate and moderate damage at 1.0 kg/ha. The apical meristem of the seedlings was not damaged in either species and elongation continued within 2 weeks of herbicide application. Even though there was slight to moderate damage to the needles of both black spruce and white spruce seedlings from some of the herbicide treatments, there was no significant reduction in height, root collar diameter, or dry weight at the end of one growing season. The addition of assist oil concentrate (83% oil/17% surfactant) did not have a significant effect on seedling growth. Sethoxydim did not significantly reduce seedling growth. ***Conclusion:*** The 12-week-old black spruce and white spruce seedlings were tolerant of applications of oxyfluorfen at the a.i. rate of 0.25 kg/ha. There was slight needle burn at 0.5 and 1.0 kg/ha but this did not result in significant reduction in growth. The seedlings for both species were tolerant of sethoxydim at a.i. rates of 0.25, 0.5, and 1.0 kg/ha. **(FORESTRY CANADA – MARITIMES, Fredericton, New Brunswick.)**

Post-emergence applications of oxyfluorfen and sethoxydim on 5-week-old black spruce container seedlings. Lanteigne, L.J.; Burns, T.W.; Hallett, R.D. 1987. (Expert Committee on Weeds – Eastern Section). ***Objectives:*** To study the effect of oxyfluorfen and sethoxydim on 5-week-old white spruce container seedlings. ***Location:*** Fraser Forest Nursery, Edmundston, New Brunswick. ***Methods:*** **Site History** – Black spruce was seeded June 19, 1986, and emerged July 3, 1986. Herbicides were applied 5 weeks post-emergence, when the seedlings were 1–2 cm in height and actively growing. **Growing Medium** – Sphagnum peat moss and vermiculite. **Application Specifications** – Treatments were applied with a pressurized CO_2 sprayer equipped with LP8003 nozzles, delivering a total spray volume of 486 L/ha at an operating pressure of 138 kPa. No rainfall was recorded within 48 hours of treatment. **Experimental Design** – Randomized complete block with five replications. **Measurements Taken** – On October 6, 1987, five seedlings per replicate (25 per treatment) were randomly selected for morphological measurements. Height (0.1 cm) and root collar diameter (0.1 mm) were measured. Data were subjected to variance analysis and means were separated using Student-Newman-Keul's multiple-range test ($P = 0.05$). Oven-dry weight for tops and roots (five trees per replicate grouped) was recorded. Data were subjected to nonparametric statistics (linear ranking) and variance analysis was performed on ranked scores ($P = 0.05$). ***Results:*** A qualitative evaluation of seedlings 1 week following herbicide application indicated that the a.i. rate of 0.25 kg/ha resulted in slight damage to the uppermost needles. There was a noticeable increase in needle damage as the rate increased. The addition of assist oil resulted in increased damage.

*Treatment**	*Rate of a.i.* (kg/ha)	*Height†* (cm)	*Dry weight† (g)*	
			Top	*Root*
Control (weeded)	—	5.5^{a}	0.23^{ab}	0.10^{a}
Oxyfluorfen	0.25	5.4^{a}	0.21^{ab}	0.08^{ab}
Oxyfluorfen + assist oil	0.25	4.8^{ab}	0.17^{bcd}	0.06^{bc}
Oxyfluorfen + sethoxydim + assist oil	0.25	5.6^{a}	0.26^{a}	0.12^{a}
Oxyfluorfen	0.5	5.0^{ab}	0.18^{abc}	0.07^{bc}
Oxyfluorfen + assist oil	0.5	5.0^{ab}	0.19^{abc}	0.08^{ab}
Oxyfluorfen + sethoxydim + assist oil	0.5	4.4^{bc}	0.15^{cd}	0.06^{bc}
Oxyfluorfen	1.0	4.2^{bc}	0.14^{cd}	0.05^{c}
Oxyfluorfen + assist oil	1.0	4.3^{bc}	0.13^{cd}	0.06^{c}
Oxyfluorfen + sethoxydim + assist oil	1.0	3.9^{c}	0.12^{d}	0.05^{c}

*Assist oil concentrate (83%/17% surfactant, BASF) was added at 1% of total spray volume.
†Means with similar superscript letters are not significantly different ($P = 0.05$).

Conclusion: Although oxyfluorfen caused needle damage to black spruce seedlings, the apical meristem was not damaged and height growth resumed within 2 weeks of herbicide application. Significant reduction in growth of black spruce seedlings can occur when oxyfluorfen is applied at a.i. rates of 0.5 and 1.0 kg/ha on 5-week-old actively growing black spruce seedlings. **(FORESTRY CANADA – MARITIMES, Fredericton, New Brunswick.)**

Post-emergence applications of oxyfluorfen and sethoxydim on 5-week-old white spruce container seedlings. Lanteigne, L.J.; Burns, T.W.; Hallett, R.D. 1987. (Expert Committee on Weeds – Eastern Section). ***Objectives:*** To study the effect of oxyfluorfen and sethoxydim on 5-week-old white spruce container seedlings. ***Location:*** Fraser Forest Nursery, Edmundston, New Brunswick. ***Methods:*** **Site History** – White spruce was seeded June 19, 1986, and emerged July 3, 1986. Herbicides were applied 5 weeks post-emergence, when the seedlings were 1–2 cm in height and actively growing. **Growing Medium** – Sphagnum peat moss and vermiculite. **Application Specifications** – Treatments were applied with a pressurized CO_2 sprayer equipped with LP8003 nozzles, delivering a total spray volume of 486 L/ha at an operating pressure of 138 kPa. No rainfall was recorded within 48 hours of treatment. **Experimental Design** – Randomized complete block with five replications. **Measurements Taken** – On October 6, 1987, five seedlings per replicate (25 per treatment) were randomly selected for morphological measurements. Height (0.1 cm) and root collar diameter (0.1 mm) were measured. Data were subjected to variance analysis and means were separated using Student-Newman-Keul's multiple-range test ($P = 0.05$). Oven-dry weight for tops and roots (five trees per replicate grouped) was recorded. Data were subjected to nonparametric statistics (linear ranking) and variance analysis was performed on ranked scores ($P = 0.05$). ***Results:*** A qualitative evaluation of seedlings 1 week following herbicide application indicated that the a.i. rate of 0.25 kg/ha resulted in slight damage to the uppermost needles. There was a noticeable increase in needle damage as the rate increased. The addition of assist oil resulted in increased damage.

*Treatment**	*Rate of a.i.* (kg/ha)	*Height*† (cm)	*Dry weight*† (g)	
			Top	*Root*
Control (weeded)	—	4.2^{a}	0.27^{a}	0.11^{a}
Oxyfluorfen	0.25	4.0^{ab}	0.21^{ab}	0.09^{ab}
Oxyfluorfen + assist oil	0.25	4.0^{ab}	0.20^{b}	0.07^{bc}
Oxyfluorfen + sethoxydim + assist oil	0.25	5.6^{a}	0.26^{a}	0.12^{a}
Oxyfluorfen	0.5	3.7^{bc}	0.18^{bc}	0.07^{bc}
Oxyfluorfen + assist oil	0.5	3.6^{bc}	0.16^{cd}	0.07^{cd}
Oxyfluorfen + sethoxydim + assist oil	0.5	3.4^{cd}	0.16^{d}	0.06^{de}
Oxyfluorfen	1.0	3.4^{cd}	0.15^{d}	0.06^{de}
Oxyfluorfen + assist oil	1.0	3.5^{cd}	0.14^{d}	0.05^{e}
Oxyfluorfen + sethoxydim + assist oil	1.0	3.1^{d}	0.13^{d}	0.05^{e}

*Assist oil concentrate (83%/17% surfactant, BASF) was added at 1% of total spray volume.
†Means with similar superscript letters are not significantly different ($P = 0.05$).

Conclusions: Although oxyfluorfen did cause needle damage to white spruce seedlings, the apical meristem was not damaged and height growth resumed within 2 weeks of herbicide application. Significant reduction in growth of white spruce seedlings can occur when oxyfluorfen is applied at a.i. rates of 0.5 and 1.0 kg/ha over 5-week-old actively growing seedlings. **(FORESTRY CANADA – MARITIMES, Fredericton, New Brunswick.)**

Effect of oxyfluorfen and lentagran on the growth of 4-week-old jack pine container seedlings. Lanteigne, L.J.; Burns, T.W.; Hallett, R.D. 1987. (Expert Committee on Weeds – Eastern Section). ***Objectives:*** To study the effect of oxyfluorfen and lentagran on the growth of 4-week-old jack pine container seedlings. ***Location:*** Department of Natural Resources' Forest Nursery, Kingsclear, New Brunswick. ***Methods:*** **Site History** – Jack pine was seeded in containers on July 2, 1986, and emerged July 11, 1986. The herbicide treatments were applied on August 7, 1986, 4 weeks post-emergence. The seedlings were 2–4 cm tall with good needle development and color. **Growing Medium** – Sphagnum peat moss and vermiculite. **Application Specifications** – Herbicides were applied with a CO_2 regulated sprayer fitted with three LP8003 nozzles delivering a total spray volume of 486 L/ha at an operating pressure of 138 kPa. **Experimental Design** – Randomized block design with five replications. **Measurements Taken** – In October 1986, five seedlings per replicate (25 per treatment) were randomly selected for morphological measurements. Height (0.1 cm) and root collar diameter (0.1 mm) were measured. Data were subjected to variance analysis and means were separated using Student-Newman-Keul's multiple-range test ($P = 0.05$). Oven-dry weight for tops and roots (five trees per replicate grouped) was recorded. Data were subjected to nonparametric statistics (linear ranking) and variance analysis was performed on ranked scores ($P = 0.05$). ***Results:*** Within 1 week of herbicide application it was observed that oxyfluorfen resulted in needle burn to the youngest foliage with a direct relationship between amount of damage and rate of application. The 1.0-kg/ha a.i. rate resulted in about 25% damage to the uppermost needles. There was no damage to the apical meristem and height growth resumed within 2 weeks of application.

Treatment	*Rate of a.i.* (kg/ha)	*Height** (cm)	*Root collar diameter** (mm)	*Dry weight** (g)	
				Top	*Root*
Control	—	10.5[a]	1.7[ab]	1.98[a]	0.75[a]
Oxyfluorfen	0.25	10.3[ab]	1.7[ab]	1.80[a]	0.63[ab]
Oxyfluorfen	0.5	9.3[bc]	1.7[ab]	1.67[a]	0.60[ab]
Oxyfluorfen	1.0	8.6[c]	1.6[b]	1.45[a]	0.51[b]
Lentagran	0.75	10.0[a]	1.7[ab]	1.91[a]	0.70[ab]
Lentagran	0.90	10.6[a]	1.8[a]	1.91[a]	0.70[ab]
Lentagran	1.35	10.3[a]	1.6[ab]	1.84[a]	0.54[ab]
Lentagran	1.80	10.1[ab]	1.7[ab]	1.87[a]	0.62[ab]

*Means with similar superscript letters are not significantly different ($P = 0.05$).

Conclusion: Oxyfluorfen at a.i. rates of 0.5 and 1.0 k/ha applied on actively growing 4-week-old jack pine seedlings will cause needle damage resulting in significant reduction in growth. Subjecting seedlings to lentagran did not result in damage or affect seedling growth. **(FORESTRY CANADA – MARITIMES, Fredericton, New Brunswick.)**

Effect of sethoxydim on the growth of 4-week-old jack pine and 8-week-old black spruce container seedlings. Lanteigne, L.J.; Burns, T.W.; and Hallett, R.D. 1987. (Expert Committee on Weeds – Eastern Section). ***Objectives:*** To study the effect of sethoxydim on the growth of 4-week-old jack pine and 8-week-old black spruce container seedlings and the influence of assist oil, ammonium sulfate, and total spray volume. ***Location:*** Department of Natural Resources' Forest Nursery, Kingsclear, New Brunswick. ***Methods:*** **Site History** – Jack pine was seeded July 2, 1986, and emerged on July 11, 1986. Black spruce was seeded June 2, 1986 and emerged on June 12, 1986. The herbicide treatments were applied on August 7, 1986, 4 weeks post-emergence for jack pine, and 8 weeks post-emergence for black spruce. Seedlings were 2–4 cm tall with good needle development and color. **Growing Medium** – Sphagnum peat moss and vermiculite. **Experimental Design** – Randomized block with five replications. **Application Specifications** – Herbicides were applied with a CO_2 regulated sprayer fitted with LP8003 nozzles. Interaction of sethoxydim at a.i. of 0.5 and 0.8 kg/ha, total spray volume at 100 and 486 L/ha, assist oil concentrate (83% oil/17% surfactant) at 2 and 4 L/ha, and liquid ammonium sulfate (486 g/L) at 4 L/ha were evaluated in relation to effect on the seedlings. **Measurements Taken** – In October 1986, five seedlings per replicate (25 per treatment) were randomly selected for morphological measurements. Height (0.1 cm) and root collar diameter (0.1 mm) were measured. Data were subjected to variance analysis and means were separated using Student-Newman-Keul's multiple-range test ($P = 0.05$). Oven-dry weight for tops and roots (five trees per replicate grouped) was recorded. Data were subjected to nonparametric statistics (linear ranking) and variance analysis was performed on ranked scores ($P = 0.05$). ***Results:*** There was no visual damage to jack pine seedlings from any of the treatments. There was no significant decrease in growth that could be attributed to the treatments. In fact, the addition of ammonium sulfate resulted in a significant increase in height (20%) and dry weight for tops (28%). Similarly, there was no visual damage to black spruce seedlings from any of the treatments, nor was there any significant decrease in growth. There was no significant effect of total spray volume (100 L/ha compared with 486 L/ha) on the growth of either black spruce or jack pine seedlings. ***Conclusion:*** Jack pine and black spruce seedlings are tolerant of sethoxydim (a.i. 0.5 and 0.8 kg/ha), regardless of total spray volume, addition of assist oil, and/or ammonium sulfate. **(FORESTRY CANADA – MARITIMES, Fredericton, New Brunswick.)**

Effect of oxadiazon and EXP4233 on the growth of black spruce and red spruce container seedlings. Lanteigne, L.J.; Burns, T.W.; and Hallett, R.D. 1987. (Expert Committee on Weeds – Eastern Section). ***Objectives:*** To evaluate the tolerance of 10-week-old black spruce and red spruce container seedlings for one and two applications of oxadiazon and EXP4233. ***Location:*** Department of Lands and Forests Provincial Nursery, Lawrencetown, Nova Scotia. ***Methods:*** **Site History** – Black spruce and red spruce were seeded March 20–21, 1986, emerged April 1, 1986, were grown in the greenhouse until June 2–5, 1986, then moved outdoors. The seedlings were 4–7 cm tall and growing vigorously at the time of treatment. **Growing Medium** – Sphagnum peat moss and vermiculite. **Application Specifications** – The rates of application for oxadiazon were a.i. at 2.4 and 3.6 kg/ha; rates for EXP4233 were a.i. at 2.2, 2.64, and 3.96 kg/ha. Both herbicides were granular formulations and were applied manually. Single treatments were applied on June 12, 1986. Double treatments were applied on June 12 and August 12, 1986. **Experimental Design** – Split-plot randomized block with five replications. **Measurements Taken** – In October 1986, five seedlings per replicate (25 per treatment) were randomly selected for morphological measurements. Height (0.1 cm) and root collar diameter (0.1 mm) were measured. Data were subjected to variance analysis and means were separated using Student-Newman-Keul's multiple-range test ($P = 0.01$). Oven-dry weight (0.01 g) for tops and roots (five trees per replicate grouped) was recorded. Data were subjected to nonparametric statistics (linear ranking) and variance analysis was performed on ranked scores ($P = 0.01$). ***Results:*** Oxadiazon and EXP4233 did not have a significant effect on height, root collar diameter, or dry weight of either red spruce or black spruce seedlings. Two applications of the herbicides in one growing season did not significantly affect growth of either species. ***Conclusion:*** Red spruce and black spruce seedlings are tolerant of single and double applications of oxadiazon (a.i. 2.4 and 3.6 kg/ha) and EXP4233 (a.i. 2.2, 2.64, and 3.96 kg/ha). **(FORESTRY CANADA – MARITIMES, Fredericton, New Brunswick.)**

Effect of oxyfluorfen, sethoxydim, and fluazifop-butyl on the growth of red spruce container seedlings. Lanteigne, L.J.; Burns, T.W.; and Hallett, R.D. 1987. (Expert Committee on Weeds – Eastern Section). ***Objectives:*** To evaluate the tolerance of red spruce container seedlings for oxyfluorfen, sethoxydim, and fluazifop-butyl. ***Location:*** Department of Lands and Forests Provincial Nursery, Lawrencetown, Nova Scotia. ***Methods:*** **Site History** – Red spruce was seeded on June 6, 1985, emerged June 14, 1985, was grown in the greenhouse until July 12, 1985 and then moved to a cold frame shelterhouse. Seedlings were actively growing at time of treatment in 1986. **Growing Medium** – Sphagnum peat moss and vermiculite. **Experimental Design** – A split-plot randomized block design with five replications. **Application Specifications** – Oxyfluorfen, sethoxydim, and fluazifop-butyl were applied at a.i. rates of 0.25, 0.50, and 1.00 kg/ha. Single application treatments were applied on June 3, 1986. Double application treatments were applied on June 3 and August 11, 1986. Herbicides were applied with a CO_2 pressure-regulated sprayer fitted with three LP8003 nozzles delivering a total spray volume of 486 L/ha at an operating pressure of 138 kPa. **Measurements Taken** – In October 1986, five seedlings per replicate (25 per treatment) were randomly selected for morphological measurements. Data were subjected to variance analysis and means were separated using Student-Newman-Keul's multiple-range test ($P = 0.01$). ***Results:*** Within 1 week following application there was slight damage to the new needles at the 0.5-kg/ha a.i. rate from all the herbicide treatments. Damage was moderate at the 1.0-kg/ha a.i. rate and was greater following the June 3, 1986 application than after the August 11, 1986 application. Damage was generally greater for the oxyfluorfen + sethoxydim treatments than for the other herbicides. It should be noted that these treatments included assist oil concentrate (83% oil/17% surfactant) at 1% of total spray volume. The assist oil enabled the oxyfluorfen to remain on the needles for a longer time and thereby resulted in greater damage to the seedlings. However, there was no damage to the apical meristem and seedlings resumed growth within 2 weeks of herbicide application. ***Conclusions:*** Oxyfluorfen at a.i. of 0.5 and 1.0 kg/ha can cause needle burn and reduce growth of red spruce seedlings, especially with two applications during one growing season and the addition of assist oil. Oxyfluorfen at a.i. of 0.25 kg/ha can be safely applied to red spruce seedlings 4 weeks post-flush. **(FORESTRY CANADA – MARITIMES, Fredericton, New Brunswick.)**

Effect of oxyfluorfen, sethoxydim, and fluazifop-butyl on the growth of 4-week-old balsam fir and 8-week-old eastern larch container seedlings. Lanteigne, L.J.; Burns, T.W.; and Hallett, R.D. 1987. (Expert Committee on Weeds – Eastern Section). ***Objectives:*** To evaluate the tolerance of 4-week-old balsam fir and 8-week-old eastern larch container seedlings to oxyfluorfen, sethoxydim, and fluazifop-butyl. ***Location:*** Department of Lands and Forests Provincial Nursery, Lawrencetown, Nova Scotia. ***Methods:*** **Site History** – Balsam fir was seeded November 6, 1985, was placed in shade area for the winter, emerged May 7, 1986, and was grown in cold frame structures. Eastern larch was seeded March 21, 1986, emerged April 1, 1986, was grown in a heated greenhouse, and was moved outside June 5, 1986. Seedlings were actively growing at time of herbicide application on June 2, 1986. The balsam fir seedlings were about 1–2 cm tall with 4–6 needles. The eastern larch seedlings were 6–10 cm tall with 15–25 needles. **Growing Medium** – Sphagnum peat moss and vermiculite. **Experimental Design** – Randomized block design with five replications. **Application Specifications** – Herbicides were applied with a CO_2 pressure-regulated sprayer fitted with three LP8003 nozzles delivering a total spray volume of 486 L/ha at an operating pressure of 138 kPa. **Measurements Taken** – In October 1986, five seedlings per replicate (25 per treatment) were randomly selected for morphological measurements. Data were subjected to variance analysis and means were separated using Student-Newman-Keul's multiple-range test ($P = 0.01$). ***Results:*** No mortality could be attributed to any of the herbicide treatments for either species and the apical meristem was not damaged. There was slight chlorosis of the needles of balsam fir which resulted in a significant reduction in height, root collar diameter, and dry weight for all the herbicide treatments. Within 1 week of herbicide applications, the uppermost needles of the eastern larch seedlings were moderately damaged from the oxyfluorfen and oxyfluorfen + fluazifop-butyl treatments and were severely damaged from oxyfluorfen + sethoxydim. This resulted in a significant reduction in height, root collar diameter, and dry weight.

Treatment	Rate of a.i. (kg/ha)	Height** (cm)	Root collar diameter** (mm)	Dry weight** (g)	
				Top	Root
		BALSAM FIR			
Control	—	5.2[a]	1.6[a]	0.73[a]	0.53[a]
Oxyfluorfen	0.5	4.2[b]	1.4[b]	0.26[b]	0.16[b]
Oxyfluorfen + fluazifop-butyl	0.5	4.5[b]	1.2[b]	0.29[b]	0.17[b]
Oxyfluorfen + sethoxydim†	0.5	4.7[b]	1.3[b]	0.31[b]	0.19[b]
		EASTERN LARCH			
Control	—	35.4[a]	3.8[a]	7.10[a]	1.66[a]
Oxyfluorfen	0.5	31.6[b]	3.5[b]	5.55[a]	1.15[b]
Oxyfluorfen + fluazifop-butyl	0.5	32.7[b]	3.5[b]	6.10[a]	1.20[b]
Oxyfluorfen sethoxydim†	0.5	30.8[b]	3.4[b]	5.73[a]	1.08[b]

**Means with similar superscript letters are not significantly different ($P = 0.01$).
†Assist oil concentrate (83% oil/17% surfactant, BASF) was added at 1% of total spray volume.

Conclusions: Additional research is required to study the effect of these herbicides on the growth of balsam fir and eastern larch. **(FORESTRY CANADA – MARITIMES, Fredericton, New Brunswick.)**

The tolerance of black spruce container seedlings to oxyfluorfen. Lenteigne, L.J.; Burns, T.W.; Hallett, R.D. 1988. (Expert Committee on Weeds – Eastern Section). ***Objective:*** To study the effect of oxyfluorfen on black spruce container seedlings. ***Location:*** Department of Natural Resources' Nursery, Kingsclear, New Brunswick. ***Methods:*** **Site History** – Black spruce was seeded and grown in the greenhouse during 1986. The seedlings were placed in an outdoor holding area for the winter of 1986–87. The experiment was conducted in spring 1987. The seedlings were 5–6 cm in height at this time. **Growing Medium** – Sphagnum peat moss and vermiculite. **Experimental Design** – Randomized split-plot with five replications. **Application Specifications** – Oxyfluorfen was applied with a CO_2 pressure-regulated sprayer fitted with three LP8003 nozzles delivering a total spray volume of 486 L/ha at an operating pressure of 138 kPa. Rates of application were at a i. of 0.25, 0.5, and 1.0 kg/ha. Treatments were applied at pre-flush, 3–4 weeks post-flush and 7–8 weeks post-flush. **Measurements Taken** – In September 1987, ten trees per replicate (50 per treatment) were randomly selected for morphological measurements. Data were subjected to variance analysis and means were separated using Student-Newman-Keul's multiple-range test ($P = 0.01$). ***Results:*** Oxyfluorfen applied 3–4 weeks and 7–8 weeks post-flush caused burning of needles immediately below the shoot apex, with a direct relationship between rate and severity of injury. Needle damage for the 3–4 weeks post-flush treatment was greater than the 7–8 weeks post-flush treatment. Height growth resumed and by the end of the growing season the needle damage was hardly noticeable. There was no significant reduction in growth with any of the treatments. ***Conclusion:*** Application of oxyfluorfen (a.i. 0.25, 0.5, 1.0 kg/ha) on overwintered black spruce seedlings applied at pre-flush, 3–4 weeks post-flush, and 7–8 weeks post-flush may result in slight needle burn but no significant reduction in growth. **(FORESTRY CANADA – MARITIMES, Fredericton, New Brunswick.)**

Influence of operational glyphosate timing in annual sequence before and after planting on conifer plantation growth. Salonius, P.O.; Murray, T.S.; Beaton, K.P. ***Objectives:*** To study the effects of operational spraying of glyphosate (Roundup/Vision) for control of competing vegetation in a sequence of years before and after planting. ***Location:*** Twelve plantation sites in New Brunswick. ***Methods:*** **Site History** – All sites previously forested, clearcut, prepared by a number of methods in 1985, and planted to a variety of conifer species early 1986. Six treatments, consisting of (1) control (no treatment), (2) spray 1985, (3) spray 1986, (4) spray 1987, (5) spray 1988, and (6) "total" spray whenever significant amount of associated vegetation present until 1988. **Soils** – Depend on areas chosen. **Application Specifications** – Glyphosate, by fixed-wing aircraft, at 4.2 L/ha. **Experimental Design** – Randomized block spray-swath-width strips, wide buffers, no replications, 150 subject seedlings per strip. **Measurements Taken** – Seedling height, height of base of live leader, mean height of competitors within 1 m, notation of competing species of first, second, and third importance within 1 m, height of tallest individual of each of these within 1 m, and percentage of colored squares on metal bar set at base of leader seen by observer 2.3 m south of seedling. In 1989, root collar diameters will also be taken. ***Results:*** Some of the operational spray applications were effective, some were not, some were missed entirely because of administrative errors. ***Conclusions:*** None so far (looking for relationships between competition index and growth). **(FORESTRY CANADA – MARITIMES, Fredericton, New Brunswick.)**

Influence of deep rototilling site preparation on containerized conifer growth as compared to crushing site preparation. Salonius, P.O.; Murray, T.S.; Beaton, K.P. ***Objectives:*** To study the influence of deep tilling on conifer and associated vegetation growth. ***Location:*** Boiestown, New Brunswick (J.D. Irving crown lease). ***Methods:*** **Site History** – Mixed spruce-fir stand with white pine, tamarack, and maple admixture, conventional clearcut 1979, entire site crushed 1980, strips tilled (MADGE ROTOCLEAR, 2.3 m swath), July 1981. Tilled and untilled strips planted with winter greenhouse-grown (24 weeks) jack pine, white spruce, black spruce, and red spruce in paperpots, styroblock no. 2, styroblock no. 4, styroblock no. 8, and styroblock no. 20 in July 1982. Competition at time of tilling consisted of raspberry, pin cherry, bracken, grass, hobblebush, softwood seedlings, hardwood stump sprouts, and others. **Soils** – Sandy loam, somewhat stony (sandstone), glacial till; moderately well drained with duff layer 5–7.5 cm thick . **Application Specifications** – No herbicide applied. **Experimental Design** – Fifty seedlings per container type of the four species in individual tilled or untilled strips, no replication. **Measurements Taken** – Seedling height, root collar diameter, rainfall during plantation year, and soil temperature at surface and 5, 10, 15, 20, 30, and 45 cm below surface. Photographic record of vegetation status (tilled and untilled). ***Results:*** Initial seedling size advantage of larger container cavities maintained up to 1987 (last measurement). Volume growth on tilled twice that on untilled. Raspberry (main competitor) reinvaded tilled soil slowly and with poor vigor. ***Conclusions:*** On this site, deep tilling is more effective than one glyphosate application at similar cost. **(FORESTRY CANADA – MARITIMES, Fredericton, New Brunswick.)**

The tolerance of red spruce seedlings to oxyfluorfen. Lanteigne, L.J.; Burns, T.W.; Hallett, R.D. 1988. (Expert Committee on Weeds – Eastern Section). ***Objective:*** To study the effect of oxyfluorfen on red spruce container seedlings. ***Location:*** Department of Lands and Forests Nursery, Lawrencetown, Nova Scotia. ***Methods:*** **Site History** – Red spruce was seeded and grown in the greenhouse during 1986. The seedlings were placed in an outdoor holding area for the winter of 1986–87. The experiment was conducted in spring 1987. The seedlings were 18–21 cm in height at this time. **Growing Medium** – Sphagnum peat moss and vermiculite. **Experimental Design** – Randomized split-plot with five replications. **Application Specifications** – Oxyfluorfen was applied with a CO_2 pressure-regulated sprayer fitted with three LP8003 nozzles delivering a total spray volume of 486 L/ha at an operating pressure of 138 kPa. Rates of application were a.i. at 0.25, 0.5, and 1.0 kg/ha. Treatments were applied at pre-flush, 3–4 weeks post-flush, and 7–8 weeks post-flush. **Measurements Taken** – In September 1987, 10 trees per replicate (50 per treatment) were randomly selected for morphological measurements. Data were subjected to variance analysis and means were separated using Student-Newman-Keul's multiple-range test ($P = 0.01$). ***Results:*** Oxyfluorfen applied 3–4 weeks and 7–8 weeks post-flush caused burning of needles immediately below the shoot apex, with a direct relationship between rate and severity of injury. Needle damage for the 3–4 weeks post-flush treatment was greater than the 7–8 weeks post-flush treatment. Height growth resumed and by the end of the growing season the needle damage was hardly noticeable. There was no significant reduction in growth with any of the treatments. ***Conclusion:*** Application of oxyfluorfen (a.i. 0.25, 0.5, 1.0 kg/ha) on overwintered red spruce seedlings applied at pre-flush, 3–4 weeks post-flush, and 7–8 weeks post-flush may result in slight needle burn but no significant reduction in growth. **(FORESTRY CANADA – MARITIMES, Fredericton, New Brunswick.)**

Hardwood stump treatments with fungi to control sprouting. Wall, R.E.; Simpson, R.A. ***Objectives:*** to determine the feasibility of using living cultures of pathogenic fungi and slash rotters to hasten stump mortality and retard sprouting. ***Location:*** Nackawic, N.B. ***Methods:*** **Site History** – The site had been occupied by mature hardwood and mixedwood stands which were clearcut between 1971 and 1975. The dense hardwood regeneration which resulted (aspen, balsam poplar, paper birch, yellow birch, red maple, sugar maple, striped maple, pin cherry, white ash, and beech) was undergoing operational spacing treatments when the treatments were applied. **Experimental Design** – Spacing was carried out with a brush saw to achieve a stocking of approximately 2 000 stems per hectare. Stumps were treated within 1 hour after felling with oil slurries of 1-month-old cultures growing on wheat bran. Oils used were heavy mineral oil, SAE no. 10W30 motor oil, and summer-grade chainsaw oil. Two isolates of the pathogenic fungus *Chondrostereum purpureum* and one isolate each of the slash rotters *Irpex lacteus* and *Polyporus versicolor* were tested. All were isolated from local forest stands. Treatments were repeated during the months of June and July 1986. In 1987, treated stumps were compared with nearby untreated stumps for fruiting bodies of the fungi used for inoculation, and for the presence of living stump sprouts. ***Results:*** Percentage of stumps with living sprouts 1 year after inoculation (number of stumps in parentheses):

Treatment	*Date*	*Treated*	*Untreated*
C. purpureum no. 1 in 10W30 motor oil	May 27	32 (75)	64 (67)
C. purpureum no. 1 in mineral oil	May 29	33 (66)	66 (105)
C. purpureum no. 2 in mineral oil	May 29	41 (54)	66 (105)
I. lacteus in mineral oil	May 29	68 (50)	66 (105)
P. versicolor in mineral oil	May 29	57 (89)	66 (105)
Sterile bran in mineral oil	May 29	36 (25)	66 (105)
C. purpureum no. 1 in 10W30 motor oil	June 3	54 (35)	87 (67)
C. purpureum no. 1 in mineral oil	June 3	25 (40)	87 (67)
C. purpureum no.1 in mineral oil containing 17% surfactant	June 3	62 (37)	87 (67)
C. purpureum no. 1 in chain saw oil	June 10	50 (26)	—
I. lacteus in chainsaw oil	June 10	60 (35)	—
Sterile bran in chainsaw oil	June 10	72 (36)	—

Fruiting of *C. purpureum* was observed on stumps inoculated with that fungus but none of the other treatments showed evidence of infection 1 year after treatment. Counts in the first plot (*C. purpureum* no.1 in 10W30 motor oil inoculated May 27, 1986 and again in September 1987) indicated that 24% of the treated stumps and 82% of the untreated stumps had living sprouts. Further observations will be made at the earliest opportunity. ***Conclusions:*** Treatment of stump surfaces with oil slurries of fungi shows some promise in hastening stump mortality and controlling regrowth by stump sprouts. Although *C. purpureum* shows the most promise in these early observations, other fungi and methods of application should be tested. There is some evidence that surfactant-free oils should be used and that oils alone can hasten stump death. **(FORESTRY CANADA – MARITIMES, Fredericton, New Brunswick.)**

Hardwood stump treatments with* Chondrostereum purpureum *to control sprouting*.** Wall, R.E. ***Objectives: To test the potential of the fungus *Chondrostereum purpureum* as a bioherbicide for stump sprout control. ***Location:*** Fredericton, N.B. ***Methods:*** **Site History** – Two young, 12–15 year old hardwood stands originating from a large clearcutting operation and located 2 km apart in the Nashwaak watershed were used. One consisted mainly of tolerant hardwoods (beech, sugar maple, striped maple, yellow birch), while the other was composed of the intolerant hardwoods trembling aspen, paper birch, pin cherry, and red maple. **Experimental Design** – Plots were established in three replicate blocks and were 0.004 ha in size. During the latter part of July all trees in each plot were felled and petri dish cultures of *C. purpureum*, isolated from the same stand, were placed over each stump. In the control plots stumps were left untreated. During the subsequent 2 years stumps were examined for the presence of the fungus and the number of living stump sprouts counted. ***Results:*** Percentage of stumps with living sprouts 1 and 2 years after inoculation (number of stumps in parentheses):

Stand	*Years after inoculation*	*Inoculated*	*Control*
Tolerant	1	39 (41)	72 (61)
	2	3*	26
Intolerant	1	67 (50)	92 (33)
	2	19	48

*Significantly different from the control at $P = 0.05$.

Two years after treatment, no living sprouts remained on treated stumps which showed evidence of infection (fruiting of the fungus on the stump surface) within 1 year after treatment. In the tolerant and intolerant hardwood stands respectively, 3 and 19% of the treated stumps and 26 and 48% of the untreated stumps had living stump sprouts after 2 years. Stumps of all hardwood species were invaded by the fungus and showed some reduction of sprouting. Paper birch showed the greatest response and aspen the least. ***Conclusions:*** *Chondrostereum purpureum* cultures could provide a reliable control for regrowth of hardwoods. Further investigation of methods of culture and application as well as potential effects on nontarget species is required. **(NEW BRUNSWICK DEPARTMENT OF NATURAL RESOURCES AND ENERGY, VALLEY FOREST PRODUCTS LTD., and FORESTRY CANADA – MARITIMES, Fredericton, New Brunswick.)**

Manual crop tree release in Estrie, 30 years of studies and results. Roberge, M.R. ***Objectives:*** To learn how various tree species established naturally or artificially and of different ages and crown positions respond to intensities of release in terms of survival and growth in diameter, height and and bole quality. ***Location:*** Dudswell Experimental Forest, Estrie, Quebec; elevation between 280 and 400 m. ***Methods:*** Sugar maple, yellow birch, and balsam fir stands were harvested annually between 1962 and 1986 using the clearcutting and shelterwood methods and areas of various sizes and forms. Some sites were prepared and some were planted with yellow birch, red oak, red spruce, Norway spruce, red pine, or European larch. Release treatments took place 2, 5, 10, 15, or 20 years after harvesting using secateurs, knives, small chain saws, or brushcutters depending on the size of competition and the intensity of release. ***Results:*** The best compromise between survival, growth rate, and quality development without corrective pruning is to release within the radius of the bole of selected crop trees. For tolerant species, the radius is 10 times the dbh of the crop tree, for semitolerant species it is 12.5 times, and for intolerant species, it is 15 times. For each metre that the competition is higher than the crop tree, the radius is increased by 25%. All vegetation that is less than half the height of the crop tree must not be cut. When possible the competing vegetation must be cut at a height only half that of the crop tree; it must never be cut at ground level. With corrective pruning, a radius 50% greater would be best because diameter growth is 30% greater. The best age or size to release is 5 years after harvesting or when crop trees or vegetation are about 2 m high; codominant and intermediate crop trees respond best. **(LAURENTIAN FORESTRY CENTRE, Sainte-Foy, Quebec.)**

Growth and survival response following a conifer-release treatment with glyphosate. Delisle, C. ***Objectives:*** To study the effects of glyphosate (ROUNDUP) on the growth and survival of jack pine and Scots pine container seedlings planted 2 years prior to treatment. ***Location:*** Grand-Mère, Quebec, Lower Saint-Maurice Management Unit; elevation 93 m. ***Methods:*** **Site History** – Farmland prior to 1926, when planted with white spruce. Clearcut in 1980. Planting spots were prepared in the spring of 1982 with a Bräcke scarifier, and planted June 9 and September 10, 1982, with jack pine and Scots pine Styroblock-8 and Quebec tube stock. On August 22, 1984, three-fifths of the experimental plots were sprayed with glyphosate. Competition at the time of treatment consisted of trembling aspen, red maple, pin cherry, white birch, red raspberry, acuminate aster, and fireweed. **Soils** – Deep fine to medium well-drained sand. **Application Specifications** – Glyphosate was applied with Echo backpack sprayer. Active rate of 2 kg/ha was applied in water totaling 270 L/ha. **Experimental Design** – Factorial design with four replications was followed for plantation. Nineteen plots out of 32 were sprayed. About half of each block was treated without considering the initial design. Each plot was composed of 121 seedlings with a 2 m × 2 m spacing. **Measurements Taken** – Survival measurements and evaluation of the quality of the seedlings were made during spring 1983, 1985, and 1987 for each seedling. Height growth and root collar diameter of 213 treated trees and 117 untreated trees were measured in September 1987. ***Results:*** Growing seasons were considered in the height and root collar diameter growth study instead of calendar year. Treatments resulted in an increase in survival for jack pine (18.7% dead trees for treated plots against 24% for untreated plots) and for Scots pine (12.3% against 22.3%); an increase in height growth was found for jack pine (163.5 cm against 146.8 cm for untreated trees) but no difference for Scots pine (96.2 cm for treated trees against 96.6 cm for untreated trees); an increase in collar diameter was found for jack pine (56.8 mm against 39 mm for June planting and 40.9 mm against 23.8 mm for September planting) and for Scots pine (34.1 mm against 32 mm for June planting and 33 mm against 23 mm for September planting). ***Conclusions:*** Glyphosate treatment reduced mortality rate of seedlings and increased height and collar diameter growth especially for jack pine. The nonsignificant difference in height growth for Scots pine was explained by browsing of terminal leaders by deer, which was recorded in greater frequency on Scots pine during the spring. **(LAURENTIAN FORESTRY CENTRE, Sainte-Foy, Quebec.)**

Enrichment of degraded stands in the Témiscouata area. Ung, C.H. ***Objective:*** To determine the optimum degree of forest cover opening through sanitation cutting in order to control the proliferation of competing vegetation and to accelerate the establishment and growth of the species introduced to enrich the degraded stands. ***Location:*** JAL, Témiscouata, Quebec; elevation 350 m. ***Methods:*** **Site History** – Timber forest approximately 50 years of age composed essentially of sugar maple from earlier overcutting. A sanitation cut was made in the summer of 1987 over two 0.25-ha blocks. Red oak acorns were sown in the fall of 1987 over part of the first block. Norway spruce seedlings were planted in the remainder of the first block and all of the second block in the spring of 1988. Competing vegetation at the time of planting was mostly mountain maple and striped maple. ***Soils*** – Loamy and stony, 45 cm deep, with 6 cm of humus. **Vegetation Control** – Initially cultural treatment with proportioning of sugar maple cover opening by sanitation cutting and, where necessary, manual clearing. **Experimental Design** – Two blocks measuring 50 × 50 m. Each block is stratified in terms of degree of cover opening. **Measurements** – For each reserved tree, rectangular coordinates, crown projection, height, and dbh are measured. For competing vegetation, height and density are to be measured twice a year from 1988 to 1992. For introduced seedlings, height and collar diameters are to be measured once a year from 1988 to 1992. **(LAURENTIAN FORESTRY CENTRE, Sainte-Foy, Quebec.)**

Black spruce outplantings in boreal Ontario: chemical site preparation with hexazinone. Wood, J.E.[1]; Campbell, R.A.[2] ***Objectives:*** To evaluate the potential of hexazinone (Velpar L) as a site preparation tool on fertile upland boreal mixedwood sites. ***Location:*** Five experiments were established across northeastern Ontario – (a) Matachewan, 305 m elevation; (b) Matachewan, 305 m elevation; (c) Matheson, 260 m elevation; (d) Hearst, 245 m elevation; (e) Matheson, 260 m elevation. ***Methods:*** **Site History** – (a) and (b) mixedwood stand (aspen, birch, spruce, pine, fir), cut for conifer in 1959–62, then subjected to several ineffective attempts at chemical and mechanical site preparation, burned by wildfire in 1977, and unsuccessfully seeded to jack pine; (c) mixedwood stand (fir, aspen, spruce, birch), cut for conifer in 1980–81, site-prepared in March 1981 with a shearing-type blade mounted on a crawler tractor; (d) mixedwood stand (spruce, aspen, birch), cut for conifer 1975, site-prepared in March 1981 with a shearing-type blade mounted on a crawler tractor; (e) mixedwood stand (spruce, aspen, birch, fir), cut for conifer 1980–81, not mechanically site prepared. **Soils** – (a) deep silt loam, moisture regime fresh to very fresh; (b) deep silt loam, moisture regime very moist; (c) deep silty clay, moisture regime moderately moist to very moist; (d) shallow sandy clay loam to deep clay loam, moisture regime very fresh on shallow crests to very moist in depressions; (e) silty clay soils, moderately to very moist. **Planting Stock** – Bareroot 1.5+1.5 transplant and 1-year-old FH408 Japanese paperpot stock planted up to 4 weeks (and in some experiments also about 1 year) after chemical site preparation. **Application Specifications** – (a) a.i. at 0.0, 4.5, and 9.0 kg/ha, applied prior to emergence of green foliage by a ground sprayer mounted on a skidder equipped with a Boom Jet 5880-OC20 boomless cluster nozzle, 15 m swath width, water carrier with total spray volume of 382 L/ha; (b) a.i. at 0.0, 1.1, 2.2, and 4.5 kg/ha, applied prior to emergence of green vegetation by a rotary-wing aircraft flying at 97 km/h and equipped with 24 D-7 nozzles (on a skid-mounted boom) oriented back 45° below horizontal and operated at a pressure of 210 kPa, 20 m swath width, water carrier with a total spray volume of 39 L/ha; (c) and (d) a.i. at 0.0, 1.0, 2.0, and 4.0 kg/ha, applied prior to emergence of green foliage by a rotary-wing aircraft flying at 97 km/h equipped with 30 6508-flat-fan nozzles on a skid-mounted boom, oriented back 45° below horizontal and operated at a pressure of 240 kPa, 15 m swath width, water carrier with total spray volume of 35 L/ha; (e) a.i. at 0.0, 2.0 and 4.0 kg/ha applied after emergence of green vegetation by a rotary-wing aircraft flying at 89 km/h, equipped with 29 6508-flat-fan nozzles (on a skid-mounted boom) oriented straight back and operated at a pressure of 200 kPa, 15 m swath width, water carrier with total spray volume of 35 L/ha. **Experimental Design** – Completely randomized, crop tree plots replicated 3 to 5 times. **Measurements Taken** – Survival, total height, height increment, and condition of crop trees assessed after first, second, third, and fifth growing season, stem diameter also measured after fifth growing season, vegetation assessed annually. ***Results:*** Reporting in progress. **([1]GREAT LAKES FORESTRY CENTRE and [2]ONTARIO MINISTRY OF NATURAL RESOURCES, Sault Ste. Marie, Ontario.)**

Competition control with Pronone applied in winter. Wood, J.E.[1], von Althen, F. W.[1]; Campbell, R.A.[2] ***Objectives:*** To determine the feasibility of applying Pronone (granular hexazinone) in the winter, its effectiveness in competition control and site preparation for black spruce outplants. ***Location:*** Matheson, Ontario; 260 m elevation. ***Methods:*** **Site History** – (a) 1985 experiment, mixedwood stand (spruce, fir, aspen, birch), cut for conifer 1984, mechanically site-prepared in February 1985; (b) 1986 experiment, see (a) for stand description, conifer component harvested in 1986, mechanically site-prepared February 1986; (c) 1987 experiment, see (a) for stand description, conifer component harvested in 1981, mechanically site-prepared in February 1987; (a), (b), and (c) mechanically site-prepared with a shearing-type blade mounted on a crawler tractor. **Soils** – (a) deep clay to sandy clay loam, moisture regime moderate to very moist; (b) deep clay with pockets of sandy clay loam, moisture regime very moist; (c) deep clay to sandy clay loam, moisture regime moist to very moist. **Planting Stock** – black spruce 1.5 + 1.5 transplants and 1-year-old FH508 Japanese paperpots planted the first spring following herbicide application or planted the first and second springs following herbicide application. **Application Specifications** – Pronone applied to frozen ground in freshly bladed strips, (a) a.i. at 0.0, 2.0, and 4.0 kg/ha for both 5G (i.e. 5% hexazinone by weight) and 10G formulations applied with Herd Seeder mounted on a three-wheel all-terrain vehicle, (b) and (c) a.i. at 0.0, 2.0, 4.0, and 6.0 kg/ha (10G formulation) applied with Herd Seeder mounted on a four-wheel all-terrain vehicle. **Experimental Design** – Randomized complete block, (a) three replications, (b) and (c) four replications. **Measurements Taken** – Survival, condition, height, and diameter of black spruce outplants measured annually for the first 3 years, vegetation assessed annually. ***Results:*** Preliminary results for experiment (a) reported in OFRC Symp. Proc. O-P-16 (p. 110); reporting on 3rd-year data from (a) and (b) and 2nd-year data from (c) in progress. (**[1]GREAT LAKES FORESTRY CENTRE, and [2]ONTARIO MINISTRY OF NATURAL RESOURCES, Sault Ste. Marie, Ontario.**)

Chemical tending of boreal black spruce plantations with glyphosate (Roundup). Wood, J.E. ***Objectives:*** To define required grades of black spruce container stock for various site conditions and seasons of planting and to define post-planting vegetation control treatments for important site conditions. ***Location:*** (a) Foleyet, Ontario; 335 m elevation; (b) Matheson, Ontario; 260 m elevation; (c) Cochrane, Ontario; 275 m elevation. ***Methods:*** **Site History** – (a) mature mixedwood stand (spruce, cedar, fir, aspen, birch), spruce harvested 1979–80, mechanically site-prepared summer 1981 by straight blade mounted on a crawler tractor; (b) mature mixedwood stand (fir, spruce, birch, aspen), conifer component harvested in 1979–80, mechanically site-prepared in February 1982 with a shearing-type blade mounted on a crawler tractor; (c) mature mixedwood stand (spruce, aspen, fir), conifer component harvested 1981, mechanically site-prepared in winter of 1981–82 with shearing-type blade mounted on crawler tractor. **Soils** – (a) 5- to 7-cm-thick humus layer, loamy to silty sand soils (pH 5.0), fresh to moderately fresh moisture regime; (b) 2- to 10-cm-thick humus layer, clay soils (pH 5.5), very fresh moisture regime; (c) 5- to 10-cm thick humus layer over silt loam to clay loam (pH 5.3), moderately moist to moist moisture regime. **Planting Stock** – Bareroot 1.5 + 1.5 transplant stock, 11-month-old FH408 Japanese paperpots, and 15-month-old FH408 Japanese paperpots planted May 1982; bareroot 1.5 + 2.0 transplant stock, 5-month-old FH408 Japanese paperpots, and 6-month-old FH408 Japanese paperpots planted in July 1982. **Application Specifications** – (a) and (b) glyphosate, a.i. at 2.14 kg/ha, applied late August 1984 to plots containing 50 outplants. Glyphosate applied with Herbi hand-held low-volume sprayer, swath width 1.75 m, water carrier, total spray volume 60 or 68 L/ha; (c) glyphosate, a.i. at 2.5 kg/ha, applied late August 1982 or 1983 to plots containing 50 outplants. Glyphosate applied in 1982 with a piston pump equipped with OC20 cluster nozzle mounted on a Nodwell Flextrac carrier, 159 kPa pressure, water carrier, 591 L/ha total spray volume. Cooper CP15 backpack sprayer used for 1983 application, 207 kPa pressure, water carrier, 300 L/ha total spray volume. **Experimental Design** – Randomized complete block; (a) and (b) three replications, (c) two replications. **Measurements Taken** – Survival, condition, total height, and height increment of outplants measured after first, second, third, and fifth growing seasons; stem diameter also measured after fifth growing season; qualitative pre- and post-spray vegetation surveys. ***Results:*** Work in progress. **(GREAT LAKES FORESTRY CENTRE, Sault Ste. Marie, Ontario.)**

Hexazinone Gridballs applied with concurrent underplanting of white spruce in boreal mixedwoods: 7-year results. Sutton, R.F. ***Objectives:*** To study the feasibility of establishing white spruce by underplanting in boreal mixedwoods treated only with Gridballs at the time of planting. Location: Chapleau, Ontario; 400 m elevation. ***Methods:*** **Site History** – (a) Fawn Twp., stand mainly jack pine–trembling aspen harvested for conifer 1970/71; (b) Highbrush Lake, mature mixedwood (aspen, birch, spruce, fir) stand burned 1967. **Soils** – (a) mildly acid, deep, till-influenced sand outwash; (b) mildly acid, deep sandy loam till, stony to very stony, with pockets of silty loam. **Application Specifications** – 2-cm^3 10% Gridballs (i.e., 10% hexazinone by mass), 3.75 g per pellet, placed manually on the forest floor without disturbance at grid spacings of 1.63 × 1.63 m and 0.95 × 0.95 m in June 1978 concurrently with outplanting of 16 white spruce, in a 4×4 block at the center of each 10 × 10 m treated plot, at the same but offset spacings. **Experimental Design** – Randomized blocks, two replications. **Measurements Taken** – Initial vegetation survey; at least annual assessment of white spruce performance for first 7 years; resurvey of vegetation 10 years after initial. ***Results:*** Up to 7th year reported in For. Chron. 62:226-232, 1986. ***Conclusions:*** The evidence is persuasive that white spruce plantations may be established in the boreal mixedwoods by underplanting and, in the same operation, applying Gridballs (or other similarly effective herbicide) at 1 × 1 m spacing. **(GREAT LAKES FORESTRY CENTRE, Sault Ste. Marie, Ontario.)**

Black spruce and jack pine underplanted through sapling hardwoods: effect of Arsenal. Sutton, R.F. ***Objectives:*** To determine the feasibility of establishing black spruce, jack pine , or both by underplanting through sapling hardwoods with post-planting over-the-top application of Cyanamid herbicide AC 252,925, subsequently designated Arsenal. ***Location:*** Sault Ste. Marie, Ontario; 210 m elevation. ***Methods:*** **Site History** – Sapling stand of presumably root sucker origin consisting of large-tooth and trembling aspen about 10 years old, with some hazel and bracken present. **Soils** – Deep outwash sand. **Application Specifications** – a.i. at 0.0, 0.5, 0.75, 1.0, and 1.25 k/ha + surfactant applied by backpack sprayer in spring or summer. **Experimental Design** – Plots 10 × 10 m split between black spruce and jack pine in randomized blocks with two replications; 16 paperpot seedlings of each species per plot planted in May 1982; herbicide applied late May or late July 1982. **Measurements Taken** – Jack pine were virtually eliminated within 1 year by browsing by hares; black spruce performance has been determined annually, vegetation changes have been recorded qualitatively. ***Results:*** By 1985, annual height increment of spruce in treated plots was about double that in untreated plots and was increasing with time in the treated plots, decreasing in the untreated. Spring application damaged leading shoots but did not kill the spruce, which subsequently responded to canopy reduction. ***Conclusions:*** Underplanting without canopy reduction did not succeed in these conditions; Arsenal applied in spring or summer effected a slow, silviculturally beneficial reduction in canopy. **(GREAT LAKES FORESTRY CENTRE, Sault Ste. Marie, Ontario.)**

Evaluation of the biological and economic benefits of pesticide use. Roberts, J.R.; Loud, P.M.; Stemeroff, M.; Stephenson, G.R.; Sutton, R.F.; Ales, C.R.; Edgington, Q.V.; Payandeh, B. Associate Committee on Scientific Criteria for Environmental Quality. National Research Council of Canada, Publication NRCC No. 23988, 293 p. ***Abstract:*** The strengths and limitations of current measures of benefits resulting from pesticide use, the economic evaluation of this yield benefit, and its subsequent distribution among different sectors of society are examined. Benefit analyses were performed for three case studies: captan on strawberries in British Columbia; fonofos on onions in Ontario; and 2,4-D/2,4,5-T on coniferous forests in New Brunswick. It was concluded that, based on current data, estimates of benefits or costs associated with a particular pest control are not a particularly useful tool in the decision-making process. Data on yield benefits as a function of crop, climate, and pest incidence on a regional basis are lacking, as is regional documentation on the level of pest infestation, total crop hectarage, and the hectarage requiring pest control. The methodology to estimate economic benefits at a producer or regional level is available, but not for estimation at the national level. Economic information lacking includes descriptions of market structures, supply and demand functions (elasticities) for the commodity and associated input markets, cultural practices, input costs, pesticide usage patterns, and actual marketed yield of major crops. Currently such information must be collected on an ad hoc basis for each benefit-cost study. **(GREAT LAKES FORESTRY CENTRE, Sault Ste. Marie, Ontario.)**

Jack pine establishment: effect of stock type, Bräcke scarification, mounding, and chemical site preparation, 3-year results. Wood, J.E.[1]; Sutton, R.F.[1]; Weldon, T.P.[1]; Rissanen, H.[2] ***Objectives:*** Self-evident from title. ***Location:*** 200 km N of Sault Ste. Marie, Ontario; 325 m elevation. ***Methods:*** **Site History** – Scattered individuals and small clumps of aspen, black spruce, and black spruce; and abundant grasses, blueberries, strawberry, and bracken. **Soils** – Deep glaciofluvial silt loams. **Application Specifications** – Roundup applied in 1.5% aqueous solution at a.i. of 2.0 kg/ha (Roundup 5.6 L/ha) to circular patches 1.4 m diameter, August 30–31, 1983, using backpack sprayers. Jack pine were planted in May 1984. **Experimental Design** – Twenty treatments, plots split by stock type, with 20 bareroot and 20 paperpot trees per plot, in four randomized blocks. **Measurements Taken** – Crop performance assessed immediately after planting and after each of the first three growing seasons; qualitative observation of other vegetation. ***Results:*** After three growing seasons, paperpot stock was larger than the bareroot stock had been after two; paperpot stock responded more strongly than bareroot to mechanical site preparation; both stock types responded positively to mounding; growth responses were consistently in favor of chemical site preparation. ***Conclusions:*** Consistently beneficial growth responses were obtained with chemical site preparation. **([1]GREAT LAKES FORESTRY CENTRE, Sault Ste. Marie, Ontario, and [2]NIKKARILAN METSAOPISTO, Finland.)**

Three-year weed efficacy results of a glyphosate conifer release trial. Reynolds, P.E.; Pitt, D.G.; Whitehead, R.; King, K. ***Objectives:*** To generate weed efficacy data for silvicultural purposes. ***Location:*** Carnation Creek Watershed, Barkley Sound, Vancouver Island, B.C. ***Methods:*** **Site History** – Coastal cedar–hemlock forest in the watershed was logged from 1975 to 1981. Portions of the watershed received various silvicultural treatments between 1976 and 1983, including scarification, prescribed burning, and planting. Sitka spruce was the primary species planted. Glyphosate treatment took place September 6–15, 1984, to release planted and naturally regenerated conifers from red alder and salmonberry competition. **Application Specifications** – Glyphosate (ROUNDUP) was applied aerially with a BELL 47 helicopter, equipped with a MICROFOIL boom. An active rate of 2 kg/ha was applied in water at a total volume of 258 L/ha. Weather during applications varied, with easterly winds ranging from calm to gusty and temperatures between 14 and 21°C. Post-applicatior rainfall varied but did not occur prior to 6 h after treatment. **Experimental Design** – Treated and untreated areas were systematically subsampled with a total of 36 and 5 permanent vegetation plots, respectively. Treated and untreated means were compared with a Student's *t* test. **Measurements Taken** – August/September 1985, 1986, and 1987. All weed species were evaluated on a scale of 0 to 10 for their health (0 = healthy, 10 = dead). Herbaceous and brush species were assessed within a 1.8 and 25-m radius of subplot center, respectively. ***Results:***

	1985			1986			1987		
Species	***Control***		***Treated***	***Control***		***Treated***	***Control***		***Treated***
Red alder	0.0	<	6.2[a]	1.0	<	3.8	0.0	<	3.2
Salmonberry	0.0	<	8.4	1.2	<	4.4	0.0	<	5.0
Thimbleberry	0.0	<	4.8	0.6	=	1.5	0.5	<	0.0
Salal	0.0	=	0.0	0.0	<	1.0	0.0	=	0.1
Sword fern	0.0	<	4.0	0.0	=	0.0	0.0	=	0.0
Deer fern	0.0	<	8.7	0.0	<	6.0	0.0	<	1.5
Lady fern	0.0	<	7.9	3.2	=	1.1	0.0	=	0.5
Red huckleberry	0.0	<	2.1	2.6	=	2.1	0.0	=	0.1
Elderberry	0.0	<	7.2	1.8	=	1.4	0.8	=	1.3

< Indicates that the control specimens are significantly healthier than the treated.
[a]Evaluated from 0 (healthy) to 10 (dead).

Conclusions: A health value of 6 or higher is considered to represent effective control of a given species. In this light, glyphosate treatment effectively controlled the major competitors for a period of 1 year, with control declining after 2 and 3 years. Although control of salmonberry was excellent, control of alder was quite variable. Salal, as expected, was not harmed by the glyphosate. **(FOREST PEST MANAGEMENT INSTITUTE, Sault Ste. Marie, Ontario.)**

Three-year crop-tolerance and growth-response results of a glyphosate conifer release trial. Reynolds, P.E.; Pitt, D.G.; Whitehead, R.; King, K. ***Objectives:*** To generate crop tolerance data for silvicultural purposes and to demonstrate the crop growth response potential of glyphosate release. ***Location:*** Carnation Creek Watershed, Barkley Sound, Vancouver Island, B.C. ***Methods:*** **Site History** – Coastal cedar–hemlock forest in the watershed was logged from 1975 to 1981. Portions of the watershed received various silvicultural treatments between 1976 and 1983, including scarification, prescribed burning, and planting. Sitka spruce was the primary species planted. Glyphosate treatment took place September 6–15, 1984, to release planted and naturally regenerated conifers from red alder and salmonberry competition. **Application Specifications** – Glyphosate (ROUNDUP) was applied aerially with a BELL 47 helicopter, equipped with a MICROFOIL boom. An active rate of 2 kg/ha was applied in water at a total volume of 258 L/ha. Weather during applications varied, with easterly winds ranging from calm to gusty and temperatures between 14 and 21°C. Post-application rainfall varied but did not occur prior to 6 h after treatment. **Experimental Design** – Treated and untreated areas were systematically subsampled with a total of 36 and 5 permanent vegetation plots, respectively. Treated and untreated means were compared with a Student's *t* test. **Measurements Taken** – August/September 1985; one representative specimen of each crop species present at each subplot was numbered, tagged, measured for total height, height increment, and root-collar diameter, and assessed for its health value. Repeat measurements were made in 1986 and 1987. ***Results:***

	1985			1986			1987		
Species	*Control*		*Treated*	*Control*		*Treated*	*Control*		*Treated*
HEALTH VALUE (0 = healthy, 10 = dead)									
Sitka spruce	0.2	=	0.0	0.8	=	0.4	0.0	=	0.0
W. red cedar	0.0	>	0.8	0.0	=	0.4	0.0	=	0.0
W. hemlock	0.0	>	0.3	0.2	=	0.0	0.0	=	0.0
ROOT-COLLAR DIAMETER (cm)									
Sitka spruce	2.9	<	3.9	3.7	<	5.0	4.5	<	6.3
ROOT-COLLAR DIAMETER INCREMENT (cm)									
Sitka spruce	0.6	=	0.8	0.8	<	1.1	0.8	<	1.3

< Indicates that the control specimens are significantly different from the treated (Student's *t* at 10 %).

Conclusions: Some minor crop injury (shoot and leader kill) was observed on hemlock and cedar one growing season after treatment. No incidences of mortality or subsequent stem deformity were observed, and the injured trees fully recovered one growing season later. Sitka spruce was unharmed by the treatment. Sitka spruce root-collar diameter and increment increased significantly in response to the release treatment. **(FOREST PEST MANAGEMENT INSTITUTE, Sault Ste. Marie, Ontario.)**

Weed efficacy and crop tolerance after spring soil treatment with liquid and granular hexazinone formulations. Reynolds, P.E.; Pitt, D.G.; Roden, M.J. ***Objectives:*** To generate weed efficacy and crop tolerance data for silvicultural purposes. ***Location:*** St. Leonard, N.B. ***Methods:*** **Site History** – Previous stand of 45% balsam fir, 35% black spruce, and 20% tolerant hardwood was clearcut in the fall of 1984 and the site prepared with a Letourneau crusher the summer of 1985. Hexazinone treatment took place May 27–29, 1986, and 2+2 bareroot black spruce were planted in June 1986 and 1987. Raspberry and grass were the major competitors at the time of treatment. **Soils** – Fine-textured, including loams, silty loams, clay loams, silty clays and clays. Duff layer varies from 3 to 11 cm. CEC and pH range from 6.2 to 18.9 and 3.6 to 4.9, respectively. **Application Specifications** – Granular hexazinone (PRONONE 10G) was applied with a skidder-mounted OMNI blower unit with a.i. at 1, 2, and 4 kg/ha. PRONONE 5G was applied with the same unit at a.i. of 2 kg/ha. Liquid hexazinone (VELPAR L) was applied with a skidder-mounted hydraulic sprayer, equipped with a cluster nozzle at a.i. of 2 kg/ha, in a total volume of 364 L/ha. **Experimental Design** – Completely randomized layout of 50 × 100 m treatment plots with four replications of each treatment. **Measurements Taken** – August 1986 and 1987. Crop health, height, height increment, and root-collar diameter for 20 trees from each planting date within each replication. Health and percentage cover of raspberry and grass from two 2-m radius subsamples within each replication. ***Results:***

	Percentage Cover				*Health* of Crop Trees, One Growing Season After Planting*		
	Raspberry		*Grass*				
Treatment	*1986*	*1987*	*1986*	*1987*	*1986 trees*		*1987 trees*
Untreated	55.0[a]	68.5[a]	5.0[a]	28.0[a]	26[a]		21[a]
VELPAR L (2 kg)	3.0[b]	4.5[b]	1.0[a]	3.5[a]	34[a]		30[a]
PRONONE 5G (2 kg)	7.5[b]	14.4[b]	3.1[a]	6.9[a]	32[a]		31[a]
PRONONE 10G (2 kg)	6.5[b]	14.4[b]	3.0[a]	12.0[a]	37[a]	**	24[a]
PRONONE 10G (1 kg)	21.3[ab]	26.8[b]	6.3[a]	18.8[a]	31[a]		27[a]
PRONONE 10G (4 kg)	3.8[b]	9.4[b]	3.8[a]	5.0[a]	35[a]		32[a]
***F*-Value**	36.86	12.03	0.91	2.23	0.65		1.63
P* >*F	0.0006	0.0001	0.4909	0.0897	0.6665		0.1947

*Evaluated from 0 (healthy) to 100 (dead).
**Indicates differences between planting times (Student's *t* at 10%).
[a,b]Indicate treatment differences – Tukey-Kramer with EW error at 5%.

Conclusions: Under the test conditions both liquid and granular formulations of hexazinone (a.i. 2 kg/ha) effectively controlled raspberry and grass and caused no adverse effects to 2+2 black spruce planted shortly after treatment. **(FOREST PEST MANAGEMENT INSTITUTE, Sault Ste. Marie, Ontario.)**

Weed efficacy and crop tolerance after spring soil treatment with sulfometuron-methyl and metsulfuron-methyl. Reynolds, P.E.; Pitt, D.G.; Roden, M.J. ***Objectives:*** To generate weed efficacy and crop tolerance data for silvicultural purposes. ***Location:*** St. Leonard, N.B. ***Methods:*** **Site History** – Previous stand of 45% balsam fir, 35% black spruce, and 20% tolerant hardwood was clearcut in the fall of 1984 and the site prepared with a Letourneau crusher the summer of 1985. Herbicide treatments took place May 29–30, 1986, and 2+2 bareroot black spruce were planted in June 1986 and 1987. Raspberry and grass were the major competitors at the time of treatment. **Soils** – Primarily silty clay loams and silty clays with a 1- to 10-cm duff layer. CEC and pH range from 8.4 to 33.5 and 3.8 to 6.2, respectively. **Application Specifications** – Both herbicides were applied with a skidder-mounted hydraulic sprayer equipped with a cluster nozzle; ALLY with a.i. at 36 and 72 g/ha, OUST with a.i. at 150, 300, and 450 g/ha, all in water at 460 L/ha. **Experimental Design** – Completely randomized layout of 25 × 50 m treatment plots with four replications of each treatment. **Measurements Taken** – August 1986 and 1987. Crop health, height, height increment, and root-collar diameter for 20 trees from each planting date within each replication. Health and percentage cover of raspberry and grass from one 2-m radius subsample within each replication. ***Results:***

	Percentage Cover				*Health* of Crop Trees, One Growing Season After Planting*		
	Raspberry		*Grass*				
Treatment	*1986*	*1987*	*1986*	*1987*	*1986 trees*		*1987 trees*
Untreated	55.0[a]	68.5[a]	5.0[a]	28.0[a]	26[a]		21[a]
ALLY (36 g)	5.0[b]	26.2[b]	1.2[a]	10.0[a,b]	40[b]	**	28[a]
ALLY (72 g)	3.8[b]	15.0[b]	5.0[a]	8.8a[b]	47[b]		35[a]
OUST (150 g)	11.2[b]	25.0[b]	3.8[a]	5.0a[b]	43[b]	**	25[a]
OUST (300 g)	7.5[b]	3.5[b]	1.2[a]	1.2[b]	51[b]	**	29[a]
OUST (450 g)	2.5[b]	6.2[b]	0.0[a]	0.0[b]	50[b]	**	28[a]
***F*-Value**	6.49	13.16	1.45	3.82	12.46		1.38
P>F 0.001	0.0001	0.2523	0.0146	0.0001			0.2760

*Evaluated from 0 (healthy) to 100 (dead).
**Indicates differences between planting times (Student's *t* at 10%).
[a,b]Indicate treatment differences – Tukey-Kramer with EW error at 5%.

Conclusions: Under the test conditions, both herbicides effectively controlled raspberry and grass (ALLY with a.i. at 72 g/ha and OUST with a.i. at 300 g/ha) and caused injury to 2+2 black spruce planted shortly after treatment. **(FOREST PEST MANAGEMENT INSTITUTE, Sault Ste. Marie, Ontario.)**

Weed efficacy and crop tolerance after fall soil treatment with liquid and granular hexazinone. Reynolds, P.E.; Pitt, D.G.; Roden, M.J. ***Objectives:*** To generate weed efficacy and crop tolerance data for silvicultural purposes. ***Location:*** St. Leonard, N.B. ***Methods*: Site History** – Previous stand of 45% balsam fir, 35% black spruce, and 20% tolerant hardwood was clearcut in the fall of 1984 and the site prepared with a Letourneau crusher the summer of 1985. Hexazinone treatment took place September 18–19, 1986, and 2+2 bareroot black spruce were planted in June 1987. Raspberry and grass were the major competitors at the time of treatment. **Soils** – Fine textured, including loams, silty loams, clay loams, silty clays, and clays. Duff layer varies from 3 to 11 cm. CEC and pH range from 6.2 to 18.9 and 3.6 to 4.9, respectively. **Application Specifications** – Granular hexazinone (PRONONE 10G) was applied with a skidder-mounted OMNI blower unit with a.i. at 2 kg/ha. Liquid hexazinone (VELPAR L) was applied with a skidder-mounted hydraulic sprayer equipped with a cluster nozzle, with a.i. at 2 kg/ha in a total volume of 436 L/ha. **Experimental Design** – Completely randomized layout of 50 × 100 m treatment plots with five, four, and three replications of each of the control, liquid, and granular treatments, respectively. **Measurements Taken** – August 1986; pre-treatment cover and health of raspberry and grass from two 2-m radius subsamples within each replication. June 1987; health, height, height increment, and root-collar diameter of 20 crop trees at the time of planting from within each replication. August 1987; repeat measurements of weeds and crop. ***Results:***

	Percentage Cover of				Health* of Crop Trees		
	Raspberry		Grass		At Planting		+ 1 Season
Treatment	pre	post	pre	post	June 1987		August 1987
Untreated	55.0[a]	68.5[a]	5.0[a]**	28.0[a]	27[a]	**	21[a]
VELPAR L (2 kg)	24.4[a]	6.3[b]	6.9[a]	3.8[a]	27[a]		24[a]
PRONONE 10G(2 kg)	18.3[a]	12.5[b]	6.7[a]	5.8[a]	29[a]		25[a]
F-Value	1.90	15.43	0.09	3.46	0.09		1.23
P >*F* 0.2055	0.0012	0.9173	0.0767	0.9147			0.3417

*Evaluated from 0 (healthy) to 100 (dead).
**Indicates differences between sample times (paired comparison with Student's *t* at 10%).
[a,b]Indicate treatment differences – Tukey-Kramer with EW error at 5%.

Conclusions: Under the test conditions both liquid and granular formulations of hexazinone effectively controlled raspberry and grass and caused no adverse effects to 2+2 black spruce planted the spring following fall treatment. **(FOREST PEST MANAGEMENT INSTITUTE, Sault Ste. Marie, Ontario.)**

Weed efficacy and crop tolerance after summer foliar treatment with sulfometuron-methyl and metsulfuron-methyl. Reynolds, P.E.; Pitt, D.G.; Roden, M.J. ***Objectives:*** To generate weed efficacy and crop tolerance data for silvicultural purposes. ***Methods:*** **Location** – St. Leonard, N.B. **Site History** – Previous stand of 45% balsam fir, 35% black spruce, and 20% tolerant hardwood was clearcut in the fall of 1984 and the site prepared with a Letourneau crusher in summer 1985. Herbicide treatments took place August 15, 1986, and 2 + 2 bareroot black spruce were planted in June 1987. Raspberry and grass were the major competitors at the time of treatment. **Soils** – Primarily silty clay loams and silty clays, with a 1- to 10-cm duff layer. CEC and pH range from 8.4 to 33.5 and 3.8 to 6.2, respectively. **Application Specifications** – Both herbicides were applied with a skidder-mounted hydraulic sprayer equipped with a cluster nozzle; ALLY with a.i. at 36 and 72 g/ha, OUST with a.i. at 150 and 300 g/ha, all in water at 447 L /ha. **Experimental Design** – Completely randomized layout of 25 × 50 m treatment plots with five replications of the control plots and four replications of each of the treatments. **Measurements Taken** – August 1986; pre-treatment cover and health of raspberry and grass from one 2-m radius subsample within each replication, health of brush species from a 5-m radius subsample within each replication. June 1987; health, height, height increment, and root-collar diameter of 20 crop trees at the time of planting from within each replication. August 1987; repeat measurements of weeds and crop. ***Results:***

	Percentage Cover of				Health* of Crop Trees		
	Raspberry		Grass		At Planting		+ 1 Season
Treatment	pre	post	pre	post	June 1987		August 1987
Untreated	55.0[a]	68.5[a]	5.0[a] **	28.0[a]	27[a]	**	21[a]
ALLY (36 g)	36.3[a] **	3.8[b]	13.8[a]	17.5[a]	29[a]	**	36[ab]
ALLY (72 g)	21.3[a]	5.0[b]	13.8[a]	22.5[a]	32[a]		31[ab]
OUST (150 g)	36.3[a] **	11.3[b]	12.5[a] **	1.3[a]	30[a]		35[ab]
OUST (300 g)	47.5[a] **	5.0[b]	10.0[a] **	0.0[a]	31[a]		41[b]
F-Value	1.03	19.82	0.51	2.03	0.43		4.41
P > *F*	0.4237	0.0001	0.7271	0.1377	0.7833		0.0136

*Evaluated from 0 (healthy) to 100 (dead).
**Indicates differences between sample times (paired comparison with Student's t at 10%).
[a,b]Indicate treatment differences - Tukey-Kramer with EW error at 5%.

Conclusions: Under the test conditions, both herbicides controlled raspberry at the rates tested. OUST also controlled grass but did not affect brush species. ALLY only had marginal effect on brush species (sugar, red and mountain maple, hazel, white birch, and elderberry) and no effect on grass. Both herbicides caused damage to 2 + 2 black spruce planted the spring following treatment. **(FOREST PEST MANAGEMENT INSTITUTE, Sault Ste. Marie, Ontario.)**

Weed efficacy and crop tolerance after site prep with sulfometuron-methyl and metsulfuron-methyl: spring soil vs. summer foliar treatment. Reynolds, P.E.; Pitt, D.G.; Roden, M.J. ***Objectives:*** To generate weed efficacy and crop tolerance data for silvicultural purposes. ***Location:*** St. Leonard, N.B. ***Methods:*** **Site History** – Previous stand of 45% balsam fir, 35% black spruce, and 20% tolerant hardwood was clearcut in the fall of 1984 and the site prepared with a Letourneau crusher the summer of 1985. Herbicide treatments took place May 29–30, 1986, and August 15, 1986, and 2+2 bareroot black spruce were planted in June 1986 and 1987. Raspberry and grass were the major competitors at the time of treatment. **Soils** – Primarily silty clay loams and silty clays with a 1- to 10-cm duff layer. CEC and pH range from 8.4 to 33.5 and 3.8 to 6.2 respectively. **Application Specifications** – Both herbicides were applied with a skidder-mounted hydraulic sprayer equipped with a cluster nozzle; ALLY with a.i. at 36 and 72 g/ha, OUST with a.i. at 150 and 300 g/ha. Spring treatments were applied in water at a total volume of 460 L/ha and summer treatments in water at 447 L/ha. **Experimental Design** – Completely randomized layout of 25 × 50 m treatment plots with five replications of the control plots and four replications of each of the treatments. **Measurements Taken** – August 1986 and 1987. Cover and health of raspberry and grass from one 2-m radius subsample within each replication. Health of brush species from a 5-m radius subsample within each replication. Health, height, height increment, and root-collar diameter of 20 crop trees at the time of planting and one growing season later from within each replication. ***Results:***

	One Growing Season After Treatment						
	Percentage Cover of						
	Raspberry		*Grass*		*Health* of Crop Trees*		
Treatment	*May*	*Aug.*	*May*	*Aug.*	*May*		*Aug.*
Untreated	55.0^{a}	68.5^{a}	5.0^{a}**	28.0^{a}	26^{a}		21^{a}
ALLY (36 g)	5.0^{b}	3.8^{b}	1.3^{a}	17.5^{a}	40^{b}		36^{ab}
ALLY (72 g)	3.8^{b}	5.0^{b}	5.0^{a}	22.5^{a}	47^{b}	**	31^{ab}
OUST (150 g)	11.3^{b}	11.3^{b}	3.8^{a}	1.3^{a}	43^{b}	**	35^{ab}
OUST (350 g)	7.5^{b}	5.0^{b}	1.3^{a}	0.0^{a}	51^{b}		41^{b}
***F*-Value**	6.27	19.82	0.94	2.03	12.93		4.41
P* >*F	0.0031	0.0001	0.4645	0.1377	0.0002		0.0136

*Evaluated from 0 (healthy) to 100 (dead).
**Indicates differences between application times (Student's *t* at 10%).
^{a,b}Indicates treatment differences – Tukey-Kramer with EW error at 5%.

Conclusions: Under the test conditions, OUST performed equally well on raspberry and grass as a spring soil treatment or a summer foliar treatment. OUST had very little effect on brush species at either application time. Ally controlled raspberry equally well at both application times but did not control grass as a foliar application. Black spruce (2+2) planted the spring following summer foliar treatment appeared to be affected less by either herbicide than did the same stock planted immediately following spring soil treatment. It is recommended that planting be delayed one full growing season after treatment, no matter when treatment takes place. **(FOREST PEST MANAGEMENT INSTITUTE, Sault Ste. Marie, Ontario.)**

Weed efficacy and crop tolerance after site preparation with liquid and granular hexazinone: spring vs. fall soil treatment. Reynolds, P.E.; Pitt, D.G.; Roden, M.J. ***Objectives:*** To collect weed efficacy and crop tolerance data for silvicultural purposes. ***Location:*** St. Leonard, N.B. ***Methods:*** **Site History** – Previous stand of 45% balsam fir, 35% black spruce, and 20% tolerant hardwood was clearcut in the fall of 1984 and the site prepared with a Letourneau crusher the summer of 1985. Herbicide treatments took place May 27–29, 1986 and September 18–19, 1986, and 2+2 bareroot black spruce were planted in June 1986 and 1987. Raspberry and grass were the major competitors at the time of treatment. **Soils** – Fine textured, including loams, silty loams, clay loams, silty clays and clays. Duff varies from 3 to 11 cm. CEC and pH range from 6.2 to 18.9 and 3.6 to 4.9, respectively. **Application Specifications** – Granular hexazinone (PRONONE 10G) was applied with a skidder-mounted OMNI blower unit with a.i. at 2 kg/ha. Liquid hexazinone (VELPAR L) was applied with a skidder-mounted hydraulic sprayer equipped with a cluster nozzle, a.i. at 2 kg/ha, in a total volume of 364 L/ha (spring) and 436 L/ha (fall). **Experimental Design** – Completely randomized layout of 25 × 50 m treatment plots with five replications of each spring treatment and five, four, and three replications of the fall control, liquid, and granular treatments, respectively. **Measurements Taken** – August 1986 and 1987. Cover and health of raspberry and grass from one 2-m radius subsample within each replication. Health, height, height increment, and root-collar diameter of 20 crop trees at the time of planting and one growing season later from within each replication. ***Results:***

	One Growing Season After Treatment					
	Percentage Cover of					
	Raspberry		*Grass*		*Health* of Crop Trees*	
Treatment	**May**	**Sep.**	**May**	**Sep.**	**May**	**Sep.**
Untreated	55.0[a]	68.5[a]	5.0[a] **	28.0[a]	26[a]	21[a]
VELPAR L	3.0[b]	6.3[b]	1.0[a] **	3.8[a]	35[a]	24[a]
PRONONE 10G	6.5[b]	12.5[b]	3.0[a]	5.8[a]	37[a]	25[a]
***F*-Value**	9.34	15.43	1.37	3.46	1.18	1.23
P* > *F	0.0036	0.0012	0.2908	0.0767	0.3461	0.3417

*Evaluated from 0 (healthy) to 100 (dead).
**Indicates differences between application times (Student's *t* at 10%).
[a,b]Indicates treatment differences - Tukey-Kramer with EW error at 5%.

Conclusions: Under the test conditions there were no detectable differences in the efficacies of the spring and fall treatments of either hexazinone formulation. Both formulations effectively controlled raspberry and grass at both application times. There were no detectable differences in black spruce (2+2) tolerance to the spring and fall hexazinone treatments for either formulation. **(FOREST PEST MANAGEMENT INSTITUTE, Sault Ste. Marie, Ontario.)**

Weed efficacy after site preparation with liquid and dry-flowable hexazinone formulations. Pitt, D.G.; Reynolds, P.E.; Roden, M.J. ***Objectives:*** To generate weed efficacy and crop tolerance data for silvicultural purposes. ***Location:*** St. Leonard, N.B. ***Methods:*** **Site History** – Previous stand of 40% red/black spruce, 40% balsam fir, and 20% aspen was clearcut in February 1986 and the site prepared with a Letourneau crusher the summer of 1986. Treatment with hexazinone took place June 23 and 25, 1987 and half of the site was planted with multipot black spruce in early August 1987. The other half of the site was planted with similar stock in August 1988. Raspberry, fireweed, and grass were the major competitors on the site at the time of treatment. **Soils** – Fine textured, ranging from loams to gravelly silt loams and gravelly clay loams. Duff layer varies from 1 to 10 cm. CEC and pH range from 16.9 to 30.4 and 4.1 to 5.4, respectively. Site is on a gentle east-facing slope. **Application Specifications** – VELPAR L was applied with a Bell 206b helicopter equipped with a Simplex boom and D10-45 nozzles. VELPAR ULW was applied with a modified Simplex seeder slung from the same aircraft. An active rate of 2 kg/ha was used for both herbicides and, in the case of the liquid, carried in a total volume of 55 L/ha. Weather conditions were similar for both applications; light overcast, no wind and temperatures between 13 and 18°C. Both applications were followed by at least 11 mm of rainfall within 24 hours. **Experimental Design** – Completely randomized layout of 1-ha treatment plots with four replications of each treatment and 48 subsamples in each replication. **Measurements Taken** – June 20 and August 13–16, 1987. Percentage cover and health of raspberry, fireweed, and grass within a 1-m radius of 48 crop-tree planting locations in each replication. Health, height, and root-collar diameter of these 48 crop trees per replication were recorded at the time of planting. ***Results:***

	Raspberry		*Fireweed*		*Grass*	
Treatment	*pre*	*post*	*pre*	*post*	*pre*	*post*
PERCENTAGE COVER						
Untreated	11.2[a] **	23.6[a]	0.9[a] **	2.8[a]	3.6[a] **	5.3[a]
VELPAR L	15.4[a] **	4.2[b]	1.3[a] **	0.03[b]	5.1[a] **	2.0[b]
VELPAR ULW	13.8[a] **	6.4[b]	1.2[a] **	0.6[c]	4.5[a]	3.6[ab]
F-Value	1.00	39.11	0.58	205.4	1.01	6.54
P >F	0.4037	0.0001	0.5820	0.0001	0.4008	0.0176
HEALTH VALUE*						
Untreated	0.4[a]	0.8[a]	1.2[a]	5.4[a]	0.3[a]	2.8[a]
VELPAR L	0.3[a] **	64.3[b]	1.8[a] **	97.2[b]	2.3[a] **	88.6[b]
VELPAR ULW	0.2[a] **	49.8[c]	1.6[a] **	63.2[c]	0.2[a] **	78.8[b]
***F*-Value**	0.49	112.57	0.51	73.02	4.69	253.27
P >F	0.6287	0.0001	0.6183	0.0001	0.0403	0.0001

*Evaluated from 0 (healthy) to 100 (dead).
**Indicates differences between pre- and post-treatment. (Paired comparison with Student's *t* at 10%)
[a,b]Indicate treatment differences – Bonferroni with EW error at 5%.

Conclusions: First-season results indicate that both hexazinone formulations effectively controlled raspberry, fireweed, and grass, and suggest that VELPAR L was slightly more effective than VELPAR ULW. Crop tolerance data will be presented as it becomes available. **(FOREST PEST MANAGEMENT INSTITUTE, Sault Ste. Marie, Ontario.)**

Results of a hexazinone–mechanical site preparation trial. Reynolds, P.E.; MacKay, T.S.; McCormack, M.L., Jr. ***Objectives:*** To generate weed efficacy and crop tolerance data for silvicultural purposes. ***Location:*** St. Leonard, N.B. ***Methods:*** **Site History** – Harvested during the winter of 1981, treated with hexazinone (VELPAR L) May 19, 1984, site prepared with a Letourneau crusher in April 1985 (including controls) and planted with 2+2 bareroot white spruce in May 1985. **Soils** – Loams, with a 1.5- to 4.5-cm duff layer. CEC and pH range from 10.6 to 13.1 and 3.7 to 4.3, respectively. **Application Specifications** – Ayers Turbo Thrush aircraft, equipped with conventional boom and whirljet nozzles, flying at 193 km/h and 17 m. Hexazinone a.i. rates were 2, 3, and 4 kg/ha in water at 93.2 L/ha. Treatment plot sizes were 445 × 84 m, with two replications of each treatment. Weather at time of application was clear, 10°C, 50% RH, with winds 3–5 km/h. Rainfall was 2.5 mm 2 days prior to application, 2 mm 1 and 2 days after application, and 27 mm 5 days after application. **Measurements Taken** – August 1984 and September 1985. Weed efficacy and crop tolerance data were collected within a 1.5-m radius of five systematically located subsamples within each treatment plot (a 25-m radius was used for brush species). ***Results:***

	Treatments							
	0 kg/ha		2 kg/ha		3 kg/ha		4 kg/ha	
Species	*1984*	*1985*	*1984*	*1985*	*1984*	*1985*	*1984*	*1985*
PERCENT CONTROL[a]								
Raspberry	0	-17	100	80	98	80	98	84
HEALTH VALUE[b]								
Elderberry	0	4	58	17	10	37	70	14
Red maple	0	36	8	47	10	40	13	52
Hazel	0	23	15	40	17	43	21	33
Mountain maple	0	43	10	10	11	64	13	49
Pin cherry	–	0	13	30	10	40	10	–
Sugar maple	–	10	10	18	18	30	10	40
Yellow birch	–	–	–	–	15	35	10	40
White spruce	–	0	–	0	–	1	–	0
Balsam fir	–	–	50	–	–	18	–	2

[a]Percent control = (pre-treat % cover – post-treat % cover)/ pre-treat % cover.
[b]Health value, evaluated from 0 (healthy) to 100 (dead).

Conclusions: The soil-applied hexazinone site-preparation treatment provided excellent control of the major weed competitor, raspberry, at the lowest rate. Crushing the chemically treated site increased raspberry cover in a number of vegetation sample quadrats, demonstrating that mechanical preparation after chemical treatment exacerbates the weed problem. Other brush species (i.e., northern hardwoods) were poorly controlled by hexazinone treatment alone. However, hardwoods that were chemically treated and crushed exhibited greater weed control than hardwoods that were crushed but not treated with hexazinone. Since hexazinone enhanced hardwood control beyond that obtained by crushing alone, it is likely that crushing in advance of chemical treatment would have increased hardwood control while precluding any enhancement of the raspberry competition. No notable injury was observed for white spruce planted after crushing in 1985. By contrast, naturally regenerated balsam fir sustained notable injury following crushing. **(FOREST PEST MANAGEMENT INSTITUTE, Sault Ste. Marie, Ontario.)**

One-year results for a hexazinone conifer release trial. Reynolds, P.E.; MacKay, T.S.; McCormack, M.L., Jr. ***Objectives:*** To generate weed efficacy and crop tolerance data for silvicultural purposes. ***Location:*** St. Leonard, N.B. ***Methods:*** **Site History** – Previous stand of sugar maple, red maple, yellow birch, balsam fir, and black spruce was clearcut in 1980–81 and subsequently site-prepared with a Letourneau crusher; 2+2 bareroot black spruce were planted in May 1982. Prior to treatment, major forest weed competition was approximately 1 m in height and consisted of raspberry and several hardwood species. Foliar application of hexazinone (VELPAR L) took place August 29 and 31, 1984. **Application Specifications** – Ayers Turbo Thrush aircraft, equipped with a thru-valve-boom and conventional whirljet nozzles, flying at 201 km/h and 17 m. Hexazinone a.i. rates were 2, 3, and 4 kg/ha in water at 93.2 L/ha. Treatment plot sizes were 477 × 84 m, with two replications of each treatment. Weather at time of application was overcast to overcast with light rain, 21–25°C, 100% RH, winds 0–8 km/h. Precipitation occurred 5 days prior to application, then heavy rain on August 30 and no precipitation until September 4. **Measurements Taken** – June 1985. Weed and crop health were assessed within a 1.5-m radius of five systematically located subsamples within each treatment plot (a 25-m radius was used for brush species). ***Results:***

	Treatments							
	0 kg/ha		**2 kg/ha**		**3 kg/ha**		**4 kg/ha**	
Species	***health[a]***	***no.[b]***	***health[a]***	***no.[b]***	***health[a]***	***no.[b]***	***health[a]***	***no.[b]***
Black spruce	0	11	0	10	7	10	16	10
Balsam fir	0	4	0	6	0	8	0	5
Raspberry	21	11	55	10	56	10	68	10
Pin cherry	8	9	61	5	32	10	80	8
Striped maple	—	0	—	0	—	0	75	2
Mountain maple	8	4	20	2	43	5	24	7
Red maple	2	9	22	10	4	10	5	10
Sugar maple	5	2	0	1	10	1	5	2

[a]Evaluated from 0 (healthy) to 100 (dead).
[b]Number of observations.

Conclusions: Foliar application of hexazinone was generally unsuccessful in controlling those forest weeds present, at all treatment rates, except for raspberry, pin cherry, and striped maple. Despite poor hardwood control, an interesting trend of control for maple species present was noted. Control was greatest for striped maple followed sequentially by mountain maple, red maple, and sugar maple. At the two higher rates, some minor injury was noted for the 2-year-old 2+2 black spruce stock. No injury was observed, at any of the rates, for naturally regenerated balsam fir present on the treated areas. **(FOREST PEST MANAGEMENT INSTITUTE, Sault Ste. Marie, Ontario.)**

Growth and tolerance of white spruce after site preparation with liquid hexazinone. Pitt, D.G; Reynolds, P.E.; Roden, M.J. ***Objectives:*** To generate weed efficacy and crop tolerance data for silvicultural purposes and to demonstrate potential crop growth response to the treatments. ***Location:*** St. Leonard, N.B. ***Methods:*** **Site History** – Harvested during the winter of 1981, treated with hexazinone (VELPAR L) May 19, 1984, site prepared with a Letourneau crusher in April 1985 (including controls), and planted with 2 + 2 bareroot white spruce in May 1985. **Soils** – Loams, with a 1.5- to 4.5-cm duff layer. CEC and pH range from 10.6 to 13.1 and 3.7 to 4.3, respectively. **Application Specifications** – Ayers Turbo Thrush aircraft, equipped with conventional boom and whirljet nozzles, flying at 193 km/h and 17 m. Hexazinone a.i. rates of 2, 3, and 4 kg/ha in water at 93.2 L/ha. Treatment plot sizes were 445 × 84 m, with two replications of each treatment. Weather at time of application was clear, 10°C, 50% RH, with winds 3–5 km/h. Rainfall was 2.5 mm 2 days prior to application, 2 mm 1 and 2 days after application, and 27 mm 5 days after application. **Measurements Taken** – August 1987. Crop height, height increment (back to the time of planting), root-collar diameter, and health of 300 randomly selected trees. Percentage cover of fireweed, raspberry, and grass within a 1-m radius of each crop tree measured. ***Results:***

	Percentage Cover of Weeds			*Status of Crop 3 Years After Planting*				
Treatment	*Raspberry*	*Fireweed*	*Grass*	*Health**	*Ht* (cm)	*Ht. incr.* (cm)	*RCD* (cm)	*Sample (no.)*
Untreated	75.3[a]	13.3[a]	14.1[ab]	33[a]	44.0[a]	6.7[a]	1.1[a]	(150)
2 kg	15.3[b]	29.6[b]	22.6[b]	16[b]	57.7[b]	15.2[b]	1.4[b]	(50)
3 kg	15.7[b]	32.9[b]	10.7[a]	18[b]	54.9[b]	13.7[b]	1.4[b]	(50)
4 kg	15.8[b]	44.5[c]	18.9[ab]	13[b]	57.0[b]	15.9[b]	1.5[b]	(50)
***F*-Value**	164.3	29.3	4.5	24.8	17.1	27.5	19.1	
P* > *F	0.0000	0.0001	0.0047	0.0001	0.0001	0.0001	0.0001	

*Evaluated from 0 (healthy) to 100 (dead).
[a,b]Indicate treatment differences–Tukey-Kramer with EW error at 5%.

Conclusions: Hexazinone site-preparation treatment (a.i. at 2 kg/ha) was successful in enhancing white spruce growth and health through the reduction of raspberry competition and the stimulation of fireweed. **(FOREST PEST MANAGEMENT INSTITUTE, Sault Ste. Marie, Ontario.)**

Environmental impact of mechanical and chemical treatments and chemical accountability of forestry herbicides. Sidhu, S.S.; Feng, J. ***Objectives:*** To study the fate of selected herbicides in the forest ecosystem and evaluate their effects on community structure, composition, and dynamics. ***Location:*** 21 km south of P & G pulp mill, Grande Prairie, Alberta (Improvement district 16, NTS Big Mountain Creek sheet), mixedwood forest complex of Alberta. ***Methods:*** **Site History** – Clearcut in 1983, 80% aspen 70–80 years old and 18–24 m high with 20% lodgepole pine. **Treatments** – hexazinone (PRONONE 10G), a.i. at 2 and 4 kg/ha in August 1986; hexazinone (PRONONE 10G) in August 1986 + disc trenching in May 1987; mechanical only (disc trenching, Rome disc) in May 1987. **Planting** – All treatment plots planted with Plug + 1 white spruce and container-grown lodgepole pine in May/June 1987. Competition at the treatment consisted primarily of dense aspen regrowth and reed grasss. **Soils** – Solonetzic Gray Luvisols developed on lacustro-till, 25–60% OM in 4–15 cm thick LH layer, moderately to imperfectly drained. **Application Specifications** – Granular hexazinone applied by isolair bucket attached to a helicopter flown at 33.5 m height and at 72.4 km/h speed. **Experimental Design** – Randomized complete block layout with three replicates of each block; treatment plots were 80 × 150 m with 30 × 100 m sampled for vegetation (30 plots, 5 × 5 m, for stem density and 120 plots, 1 × 1 m, for cover estimates in each treatment plot). **Measurements Taken** – Spring 1986 to fall 1988; stem density of woody species over 50 cm and cover of all species, residues in vegetation, soil, water, and sediments, vertical (in soil) and offsite movement of the herbicide, analytical methods for hexazinone in soil and vegetation, effects on ectomycorrhizal development in white spruce and lodgepole pine. ***Results:*** Available on distribution of granules by aerial and ground application, release of hexazinone under simulated and field conditions, residues in soil leachates, effects on vegetation (preliminary). ***Conclusions:*** In 1990/91. **(NORTHERN FORESTRY CENTRE, Edmonton, Alberta.)**

Nutrient cycling and dynamics in relation to toxic substances and silvicultural practices. Maynard, D.G. ***Objectives:*** Determine the influence of herbicide application on nutrient cycling and the decomposition of organic matter. ***Location:*** 21 km south of P & G pulp mill, Grande Prairie, Alberta (Improvement district 16, NTS Big Mountain Creek sheet), mixedwood forest complex of Alberta. ***Methods:*** **Site History** – Clearcut in 1983, aspen 80% 70–80 years old and 18–24 m high with 20% lodgepole pine. **Treatments** – PRONONE, with a.i. at 2 and 4 kg/ha hand applied in 15 plots, 8 × 8 m. Competition at treatment time consisted primarily of dense aspen regrowth and reed grass. **Soils** – Solonetzic Gray Luvisols developed on lacustro-till, 25–60% OM in 4–15 cm thick LH layer, moderately to imperfectly drained. **Application Specifications** – hexazinone (PRONONE 10G) applied by hand. **Experimental Design** – Randomized complete block layout with five blocks (8 × 8 m). **Measurements Taken** – Measurements taken in 1987 and 1988 on stem density of woody species over 50 cm and cover of all species, litter in litter collectors, soil leachates from lysimeters. ***Results:*** Available in 1990. ***Conclusions:*** In 1990–91. **(NORTHERN FORESTRY CENTRE, Edmonton, Alberta.)**

Silvicultural assessment of selected methods of site preparation and crop release in areas designated for softwood production in Alberta – main test site – Grande Prairie. Brace, L.G. ***Objectives:*** Assess effects of selected manual, mechanical, chemical, and combined treatments for site preparation and release of white spruce and lodgepole pine crop trees, and assess effects of chemical treatments on small-mammal populations. ***Location:*** 21 km south of P & G pulp mill, Grande Prairie, Alberta (Improvement district 16, NTS Big Mountain Creek sheet), mixedwood forest complex of Alberta. ***Methods:*** **Site History** – Clearcut in 1983, aspen 80% 70–80 years old and 18–24 m high with 20% lodgepole pine. **Treatments** – hexazinone (PRONONE 10G), with a.i. at 2 and 4 kg/ha in August 1986; hexazinone (PRONONE 10G) in August 1986 + disc trenching in May 1987; mechanical only (disc trenching, Rome disc) in May 1987. **Planting** – All treatment plots planted with Plug + 1 white spruce and container-grown lodgepole pine in May/June 1987. Competition at the treatment site consisted primarily of dense aspen regrowth and reed grass. **Soils** – Solonetzic Gray Luvisols developed on lacustro-till, 25–60% OM in 4–15 cm thick LH layer, moderately to imperfectly drained. **Application Specifications** – Granular hexazinone applied by isolair bucket attached to a helicopter flown at 33.5 m height and at 72.4 km/h speed. **Experimental Design** – Randomized complete block layout with three replicates of each block, treatment plots were 80 × 150 m with 30 × 100 m sampled for vegetation (30 plots, 5 × 5 m, for stem density and 120 plots, 1 × 1 m, for cover estimates in each treatment plot). **Measurements Taken** – Spring 1986 to fall 1988; competing vegetation measurements according to ECW protocols (vigor, height, status, damage) and crop tree survival and growth (height, diameter). ***Results:*** Crop-tree, competing vegetation, and small-mammal results tentative and no published report to date. ***Conclusions:*** 3year results 1990/91 and 5-year results 1992/93. **(NORTHERN FORESTRY CENTRE, Edmonton, Alberta.)**

Control of aspen development in areas designated for softwood production. Navratil, S. ***Objectives:*** To assess effects of chemical single tree pre-harvest treatments and mechanical, manual, and chemical treatments for site preparation and release on density and growth of aspen regeneration.

Main test site: ***Location:*** 21 km south of P & G pulp mill, Grande Prairie, Alberta (Improvement district 16, NTS Big Mountain Creek sheet), mixedwood forest complex of Alberta. ***Methods:*** **Site History** – Clearcut in 1983, aspen 80% 70–80 years old and 18–24 m high with 20% lodgepole pine. **Experimental Design** – Randomized complete block layout with three replicates of each block, treatment plots were 80 × 150 m. In each treatment plot, 20 20-m^2 plots (aspen vigor, status, damage, height, diameter, age), and in mechanical treatments 10 20-m^2 plots and/or 10 longitudinal transects (aspen root density, diameter, wounding, segmentation, and suckering) were sampled. **Measurements Taken** – Fall 1985 to fall 1988, the above variables.

Satellite test site A: ***Location:*** Lac La Biche Forest, Calling Lake District, 6 km east on South Chevron road. ***Methods:*** **Site History** – Aspen–white spruce stand damaged by a tornado was salvage-logged and debris piled in the winter of 1985–86. **Soils** – Sandy loam to sandy clay, Orthic Gray Luvisol. **Treatments** – Velpar with a.i. at 3 kg/ha, applied with backpack sprayer + extended boom, double-pass Rome disc, Marttiini, straight blade, Marttiini + release, control in fall 1986. Planted with 3-0 white spruce in May 1987. **Experimental Design** – Randomized complete block layout with four replicates of each block, treatment plots are 42.5 × 50 m; 20 20-m^2 plots for pre- and post-treatment assessments of aspen regeneration in each treatment plot. **Measurements Taken** – Summer 1986 to summer 1988, aspen vigor, damage, status, height, diameter, age, root segmentation; crop tree height and overtopping.

Satellite test site B: ***Location:*** Peace River Forest, Weberville, 50 km north of Peace River. ***Methods:*** **Site History** – Aspen stand, phase III inventory D2A-H, approx. 65 years old; clay soil, Orthic Gray Luvisol. **Treatments** – Single-tree treatments with glyphosate (hack and squirt Vision; Gel-Cap; Carbopaste), hexazinone (hack and squirt Velpar, Swedish dry notch tablet), and pre-harvest spotgun application of Velpar with a.i. at 3 kg/ha in June 1987, post-harvest single and double Rome disc in summer 1988, control. Planted with container white spruce in fall 1988. **Experimental Design** – Randomized complete block layout with four replicates of each block, treatment plots 42.5 × 50 m; 20 20-m^2 plots for assessment of aspen regeneration and crop trees in each treatment plot. **Measurements Taken** – Crown mortality of aspen parent trees in fall 1987.

Satellite test site C: ***Location:*** Peace River Forest, north of Hines Creek. ***Methods:*** **Site History** – Fire origin, white spruce–aspen stand 120–150 years old, to be harvested in fall 1988. **Treatments** – Single-tree applications of hexazinone (1 mL/2.5 cm dbh of 50% solution of Velpar by hack and squirt method and solid pellet by Swedish dry notch method) and 2,4-D (1 mL/3.0 cm dbh and double dosage of Formula 40) in June 1987. **Experimental Design** – Randomized complete block layout with four replicates of each block, treatment plots are 60 × 70 m. Assessment plots in cardinal directions to ECW protocol. **Measurements Taken** – Crown mortality of aspen trees in summer and fall 1988. ***Results:*** N/A. ***Conclusions:*** N/A. **(NORTHERN FORESTRY CENTRE, Edmonton, Alberta.)**

CFS-Abitibi-Price site-stock trials. Ball W.J. ***Objectives:*** To test field performance of two types of spring-planted black and white spruce on trenched and untrenched open areas and corridors previously winter-bladed and sprayed with Roundup. ***Location:*** Pine Falls, MB Eastern Region, elevation 256 m. ***Methods:*** **Site History** – Stand composition: trembling aspen 70%, white spruce 30%; age 80–100 years; height 26 m. Harvest method: Hwy 304 1930s, white spruce only, winter bucksaw and horse; Bear River 1960s white spruce only, winter cut and skid. Mechanical site preparation: (a) Primary, 1, Hwy 304 strips, winter 1987, corridors bladed (two blades wide) with D7G tractor equipped with a Rome side cutting blade; 2, Hwy 304 open areas, winter 1986, D8K tractor equipped with V-cutting blade and D7G tractor equipped with straight piling blade; 3, Bear River open areas, winter 1982, D8K tractor equipped with V-cutting blade and D7G tractor equipped with straight piling blade. (b) Secondary, 1, Hwy 304 strips, alternate strips trenched with a Donaren disc trencher; 2, open areas (Hwy 304 and Bear River), half of each open area trenched with a Donaren disc trencher. Competition: Hwy 304 strips, east half vigorous 40-year aspen, west half and Bear River decadent aspen; all locations beaked hazel with Manitoba maple and black ash on moister sites. **Soils** – Bear River clay; Hwy 304 areas clay to sand. Duff 5–10 cm. Moisture regimes 3–5. **Application Specifications** – Chemical treatments: 1, Hwy 304 strips, ground application August 1987; 2, Hwy 304 open areas, August 1986; 3, Bear River, fixed wing (two applications, August 1982 and August 1984). All ground applications with Clark 664 skidder equipped with two 450-L tanks. Swath width 5.5 m in strips and 11 m in open areas. Boom none; one cluster nozzle. Application rates: 1986 2.5 L/ha; 1987, 4.0 L/ha. Carrier: water, no adjuvants, total volume 112 L/ha. Aerial applications with Ag-Cat at 2.5 L/ha both in 1982 and 1984, no adjuvants, total volume 37 L/ha. **Experimental Design** – Strip areas: two split-block experiments with 2 main treatments (trenched and untrenched) × 2 areas × 10 blocks × 20 samples × 2 stock types × 2 species for 3 200 pinned seedlings. Open areas: four randomized block experiments of 4 stock treatments × 2 site-preparation treatments × 2 areas × 20 samples for 3 200 pinned seedlings. June planting 1988. **Measurements Taken** – After-planting height and root collar diameter respectively for spruce Can-Am 2 were 154 and 2.02 mm; for black spruce G + 1 transplants, 182 and 3.31 mm; for white spruce Can-Am 2, 205 and 1.93 mm; and for white spruce 1.5 + 1.5 transplants, 230 and 5.35 mm. **(CANADIAN FORESTRY SERVICE, Manitoba District Office, Winnipeg, Manitoba.)**

The effect of scalping and cultivating (prior to planting) on the survival and growth of white spruce on mesic clay loams. (Jarvis, J.) Ball, W.J. ***Objectives:*** To determine effects of blading, no blading, spading, and controls on survival and growth of white spruce transplants. ***Location:*** Riding Mountain National Park, elevation 690 m. ***Methods:*** **Site History** – Mixedwood stands of overmature trembling aspen and uneven-aged white spruce with a dominant understory of beaked hazel. Half of each block was severely scalped with a bulldozer; half of each of these main treatments was spaded. Ten blocks were prepared in 1962, 1963, and 1964 for planting of uniformly graded white spruce transplants in 1963, 1964, and 1965. Areas were fenced; shrubs such as hazel were cut with a "brush master" and all vegetation was mowed with a lawnmower until 1969; fences were removed shortly after 1969. **Soils** – Moderately well drained Orthic Gray Luvisols. Blading depth 15 cm; spading 30 cm. **Experimental Design** – Split plot; each 12.2 × 12.2 m plot divided in half; randomized main plots were (1) summer-bladed in 4.9-m-wide strips and (2) not bladed. Half of each main plot was subdivided at random into spaded (soil turned over manually with a shovel) subplots. **Measurements Taken** – Height growth and mortality data were measured annually until 1969 and thereafter in 1973, 1981, and 1986. ***Results:*** All three years of replication show clearly that summer blading improved long-term survival of white spruce transplants significantly. However, this treatment had a profound, lasting, and significant impact on total height, height increment, and diameter. The spading treatment, which did not affect growth, improved survival on non-bladed plots in two of the three trials. Diameters on non-bladed plots averaged 60% greater than those on bladed plots. Total height 21–23 years after planting averaged more than 1 m, or about one-third more on non-bladed plots. Annual height increment was significantly greater on non-bladed plots in all replications, even at age 8–10, indicating that differences in total height are still increasing. **(NORTHERN FORESTRY CENTRE, Manitoba District Office, Winnipeg, Manitoba.)**

Stem injection and girdling of residual aspen. Gardner, A. ***Objectives:*** Control of aspen sucker density following softwood removal. ***Location:*** Prince Albert, Saskatchewan; boreal mixedwood, elevation 451 m. ***Methods:*** **Site History** – 20C (black spruce, jack pine, and trembling aspen clearcut in winter 1985–86) no site preparation or planting on experimental area, no revegetation at time of plot establishment. Residual aspen stems per hectare averaged 35 for herbicide treatment, 34 for girdling, and 27 for control; all stems healthy at time of treatment. **Application Specifications** – Three treatments investigated, herbicide, girdling, and control. Herbicide application by punch hammer and spot gun calibrated to deliver 1.0 mL of undiluted glyphosate formulation to punch holes located every 10 cm around stem circumference. Girdling by frilling with an axe. Weather was clear, 23°C, no wind. **Experimental Design** – Three replications per treatment were established. Plots are 100 × 100 m with 50 × 50 m sample plots located inside. A 25-m treated buffer surrounds each sample area. A total of 9 ha for the experiment is arranged in a completely randomized single-factor design. **Measurements Taken** – Aspen density, average total height of aspen, morphological and physiological description of aspen and dominant vegetation. **(NORTHERN FORESTRY CENTRE, Saskatchewan District Office, Prince Albert, Saskatchewan.)**

Comparison of four treatment options for weeding shrub-dominated spruce plantations. Whitehead, R.J. ***Objectives:*** For four treatment options (broadcast application of glyphosate with a.i. at 1.8 kg/ha, broadcast application of 2,4-D amine with a.i. at 3.0 kg/ha, clearing-saw removal, and no treatment), to determine and compare crop tree growth response, growth response of major target weed species, and changes in plant community composition and structure, over a 5-year period. ***Location:*** Bush River drainage, 110 km north of Golden, B.C. in the Upper Kootenay–Columbia Moist Southern Interior Cedar–Hemlock zone (ICHa2(04)). ***Methods:*** **Site History** – The block was ground-logged in winter 1981, prepared by broadcast burning in spring 1983, and planted to 1275 stems per hectare (sph) with Engelmann spruce 2+0 bareroot stock in spring 1984. By fall 1985, spruce were overtopped by a shrub–forb complex consisting primarily of thimbleberry, raspberry, and fireweed at 0.7–1.4 m height; stocking levels were down to 584 sph. The area was fill-planted with Engelmann spruce 1+0 PSB 313 stock in spring 1986. **Treatment Specifications** – Herbicide treatments were applied using a Cooper-Pegler CP-3 backpack sprayer in water carrier at total solution rate of 40 L/ha. Husqvarna 165r clearing saws with MAXI 255 blades were used to clear all vegetation as close to ground level as practically achievable. All treatments were applied in mid to late August 1986. **Experimental Design** – Randomized complete block with three replications, each treatment plot being 60 × 60 m square. Within each plot, one 400-m^2 subplot was permanently established for assessment of community composition and structure, 20 10-m^2 circular subplots were established each with a tagged representative of thimbleberry and raspberry for measurement of target species response, and 30 spruce trees (of each planting) were tagged for assessment of crop growth response. **Measurements Taken** – Pre-treatment, and 1,2,3, and 5 years post-treatment: crop tree foliage, stem and leader condition, height, leader increment, and stem diameter; foliage and stem condition, height, and ground cover percentage for thimbleberry, raspberry, and fireweed; cover-abundance, distribution code and vigor of all species, by plant layer (height class). ***Results:*** Not available; first 3 years' results will be reported as a Canada/B.C. FRDA Research Report in December 1989. **(PACIFIC FORESTRY CENTRE, Victoria, British Columbia.)**

An evaluation of cost-effectiveness of clearing saw treatments for weeding young shrub-dominated conifer plantations – Phase II: Silvicultural efficacy. Whitehead, R.J. ***Objectives:*** To evaluate growth responses of crop trees and major competing species to three brushing intensities (not brushed, brushed once, and brushed annually). ***Location:*** Redfish Creek, 25 km east of Nelson, B.C., in a submesic association of the Lower Columbia–Kootenay Moist Southern Interior Cedar–Hemlock biogeoclimatic subzone (ICHa1(03)). ***Methods:*** **Site History** – Ponderosa pine/Douglas-fir seed tree cut in 1981–1983, with portions prepared by controlled underburns in 1984 and 1985 and spot-planted as required. The study area includes a mixed stand of planted ponderosa pine, western larch, and natural Douglas-fir and grand fir. **Experimental Design** – Nine treatment units (50 × 50 m) were established in a completely randomized design with three treatment levels (not brushed, brushed once, brushed annually). **Measurements Taken** – Pre-treatment, and 1,2,3, and 5 years post-treatment. Within each treatment unit, thirty crop trees are assessed for condition, free-growing status, and height and diameter growth; 20 10-m^2 circular subplots are established for assessment of percentage cover and modal height of the major competitive complex, and percentage cover of each of the three major species present. Individuals of these three species are tagged for assessment of height and vigor. Changes in the composition and structure of the plant community are assessed by descriptive measures of cover abundance, distribution, and vigor in a central 20 × 20 m macroplot. ***Results:*** The trial was established in August 1987. An interim report, including second-growing-season results, will be available as a Canada/B.C. FRDA Research Report in March 1990. **(PACIFIC FORESTRY CENTRE, Victoria, British Columbia.)**

An evaluation of cost-effectiveness of clearing-saw treatments for weeding young shrub-dominated conifer plantations – Phase I: Cost, productivity, and crop damage. Holmsen, S.D.[1]; Whitehead,R.J[2]. ***Objectives:*** To obtain estimates for cost, worker productivity, and accidental crop damage at time of treatment and to compare productivity of three cutting attachments. ***Location:*** Redfish Creek, 25 km east of Nelson, B.C,. in a submesic association of the Lower Columbia-Kootenay Moist Southern Interior Cedar–Hemlock biogeoclimatic subzone (ICHa1(03)). ***Methods:*** **Site History** – Ponderosa pine–Douglas-fir seed trees cut in 1981–1983, with portions prepared by controlled underburns in 1984 and 1985 and spot-planted as required. The study area includes a mixed stand of planted ponderosa pine, western larch, and natural Douglas-fir and grand fir. **Experimental Design** – Fifty-four treatment units, each 16.7 × 25 m, were arranged in a factorial design (3 vegetation types × 3 blade types × 2 operators) replicated three times. **Measurements taken** – Time and motion measurements were taken in each treatment unit. The 308 conifer seedlings were tagged before treatment and assessed pre- and post-treatment for condition and overtopping status. ***Results:*** Averaged over all vegetation types and blade types, worker productivity was 0.025 ha per productive hour (range 0.023 – 0.030); extrapolation to an 8-hour day with 80% utilization of time yielded an average of 6.3 worker-days per hectare. Average treatment cost was $775/ha, based on saw and operator costs of $15.40/h. Significantly higher productivity during actual clearing time was obtained with the MULTI 300 blade in smaller-stem-size vegetation. Although the MAXI 200 was slower overall, it was the only blade tested that was suited for stems over 2 cm in diameter. Nearly one in five crop trees assessed had damage attributed to treatment. Frequency of direct saw damage was related to visibility of the seedling within the shrub complex; less damage was noted on trees with projecting leaders than on overtopped stems. Results are published as FERIC Special Report No. SR-52 and as Canada/B.C. FRDA Research Report No. 028. (**[1]FOREST ENGINEERING RESEARCH INSTITUTE OF CANADA, Vancouver, B.C. and [2]PACIFIC FORESTRY CENTRE, Victoria, British Columbia.**)

Forest vegetation ecology. Oswald, E.T. ***Objectives:*** To elucidate nonchemical techniques that will enhance establishment and growth of commercial tree species in competitive environments. ***Location:*** Subalpine forests at Skelly Creek near Creston, and Glenogle Creek near Golden, Nelson Forest District, southeastern British Columbia. ***Methods:*** **Site History** – At Glenogle Creek the site was logged in the early 1970s, burned, and planted, but survival was poor to nonexistent creating NSR sites. In 1986 the site was scarified using various techniques (V-plow, brush blade, dip and dive, some with the contour and some across the contour), or burned and replanted. At Skelly Creek relocatable plots are established in forest stands scheduled for summer and winter logging; thus the sites are uncut at the time of plot location. These sites support Engelmann spruce and alpine fir in a community characterized by false azalea, white-flowered rhododendron, and black blueberry. **Soils** – Both areas are moist subalpine (ESSFc = moist Englemann spruce–subalpine fir) between 1550 and 1750 m elevation, thus soil materials have been influenced by alpine glaciation; those at Glenogle Creek are gravelly silt loams and those at Skelly Creek are gravelly or sandy loams often with many boulders. **Experimental Design** – Line-intercepts 10 m in length are located randomly in each type of scarification at Glenogle Creek and each block at Skelly Creek for measuring the height and cover of woody species. Along each line, five 2×5 dm plots are used for measuring cover of herbs, bryophytes, and lichens. In the scarified areas, five Englemann spruce seedlings occur along each intercept line; a similar arrangement will be devised in Skelly Creek after planting. Microloggers are used for measuring microclimate. **Measurements Taken** – The height and cover of woody plants and cover of nonwoody plants were measured at Glenogle during 1987, and such measurements will continue each year for 5 years. In addition the height, last year's increment, and basal diameter of each of the five seedlings along the transect were measured and the color, vigor, and general condition of each seedling were recorded. Similar measurements on the woody and herbaceous plants were done in part of Skelly Creek prior to logging. Subsequent measurements will be taken following burning and planting, and will include the seedling measurements. Two climatic stations have been located in scarified sites at Glenogle and one year's data have been obtained; the measurements include rainfall, soil and air temperatures, relative humidity, insolation, and wind speed. One station is located within a mature forest at Skelly Creek. ***Results:*** All the scarification procedures make a planting site that is free of competing plants by removing the organic layer and upper soil material. In all cases the depth of scarification varied somewhat. Seedlings were planted most often along the edges of the scarification track. The greatest amount of invasion by competing plants occurred in shallow cuts or where organic matter remained. In the burnt lands, drag lines were made with a brush blade and were thus similar to the scarified lines. Planting was done along both edges of the drag lines in addition to the burned land. The most common invader was fireweed, but most shrubs started growth from root stalks. Preliminary data indicate that seedlings do better in burned sites than in skid rows or scarified tracks; however, at least 2 years are required for the seedlings to get attuned to the planting site. ***Conclusions:*** Early indications are that alteratives to scarification in mountainous topography must be found; it is expensive and Englemann spruce seedling growth seems poor, perhaps due to the removal of organic matter and thus the nutrient source for the seedlings. **(PACIFIC FORESTRY CENTRE, Victoria, British Columbia.)**

Biological control of forest weeds. Dorworth, C.E. ***Objectives:*** To identify forest weed problems that are amenable to control approaches that incorporate biological control agents, to identify those agents potentially most successful for use in constraining growth of forest weeds, and to develop technology for use of bioagents to such a point, and with such industrial potential, that it can be transferred to an appropriate production and marketing agent. Simultaneously, information relating to weed biocontrol is presented to clients and other groups in order to promote public awareness of the potential uses for biological control. ***Location:*** Primary research areas are southern Vancouver Island and the Peace River area of northern interior British Columbia. Current research sites on Vancouver Island include the Sarita and Shawnigan Licenses (MacMillan Bloedel) with reference to salal, and the recent Western Forests Products replant area along the Sombrio River from Highway 14 to the ocean with respect to fireweed. An area between Victoria and Duncan (Cobble Hill) has been secured for establishment of a provenance arboretum for alder, salal, and perhaps fireweed and for inoculations of red alder. Research to control bigleaf maple occurs on CIP land near Mesachi Lake. Other research is conducted near Victoria and in the PFC greenhouse. ***Methods:*** **Experimental Design** – Crop tree–weed problems, many of which are disclosed by FRDA studies or from the forest industry, are first evaluated through immediate examination of natural situations, perusal of federal and provincial reports, or cooperation with forest managers and forestry research personnel, to determine those amenable to solution by means of biocontrol agents. Diseased weeds are collected and the associated microorganisms are identified, cultured, and reinoculated onto healthy weeds in the greenhouse or into tissue cultures (1988 projected). Potentially useful bioagents are then inoculated onto or into appropriate weed species in the field for intensified testing. Simultaneously, a variety of means are tested to weaken the target weeds so that they can be more easily infected and colonized by microorganisms selectively. Diseased examples of the host plants selected for primary attention (mostly bigleaf maple, red alder, fireweed, and salal) were treated by standard microbiological isolation methods and the fungi obtained thereby were purified (brought to the point of axenic culture), characterized, placed in semipermanent storage for referral, and tested on the original target plants by various methods. Only native bioagents will be dispersed into the forest or onto experimental plots, and weed growth constraint will depend at least partly on new technology designed to predispose the hosts to maximum damage during the course of the host–pathogen interaction; some FRDA studies are contributing to the success of this research. **Measurements Taken** – Most experiments are of insufficient maturity to evaluate as yet. Measurements will eventually focus on elements of plant (weed) growth that are responsible for competetiveness of each weed species with respect to the desired crop plants (usually conifers). Further efforts on development of somoclonal lines of target host species for laboratory inoculation will be done to provide a rapid assay of bioagents and provide a safe site for comparitive inoculations with exotic bioagents. ***Results:*** Results after 1 year are good in the sense of study initiation and laboratory setup and trivial in terms of specific experimental results to date. ***Conclusions:*** Initial host plant responses are sufficient to warrent continuation of the work. Initial efforts have enabled workers to develop methods for this new work (this is the only full-scale forest weed mycoherbicide project in North America), and focus attention where best results might be achieved. **(PACIFIC FORESTRY CENTRE, Victoria, British Columbia.)**

Stump and frill treatments of red alder with pathogenic fungi to hasten mortality and prevent sprouting. Wall, R. E. ***Objectives:*** To apply and expand on findings with respect to the use of *Chondrostereum purpureum* in eastern hardwoods and to the control of red alder on the Pacific coast. ***Location:*** Victoria and Sooke, B.C. ***Methods:*** **Site History** – Upland sites where dense growth of alder occupies a power line right-of-way (Victoria) and a Douglas-fir plantation (Sooke) were chosen for stump and frill treatments. **Experimental Design** – All alder >5 cm dbh were numbered and selected at random for various treatments. Twenty trees are being used for each treatment, and stump and frill treatments are spatially separated. Treatment variables include fungi (three local isolates of *Chondrostereum purpureum* as well as other promising stem pathogens isolated from alder), formulation (intact plate cultures, oil slurries, macerated mycelia), and season. Efficacy measurements will consist of (1) extent of cambial necrosis from the point of inoculation (frill or stump surface), (2) development and mortality of stump sprouts, and (3) time interval between inoculation and crown mortality in the case of frill inoculations. ***Results:*** Early measurements of cambial necrosis on stumps inoculated in April, 1988:

Treatment	*Number of stumps*	*Extent of cambial browning (cm) ± S.E.*
C. purpureum		
isolate no. 1	9	4.1 ± 2.6
isolate no. 2	9	7.1 ± 5.0
isolate no. 3	9	4.3 ± 2.2
Control	9	0.1 ± 0.1

Conclusions: The preliminary data indicate that the fungus may have become established and is beginning to penetrate the stumps. Inoculations during the latter part of the growing season and during the dormant period need to be compared. **(PACIFIC FORESTRY CENTRE, Victoria, British Columbia.)**

Biological controls for* Rubus *spp. Wall, R.E. ***Objectives:*** to find suitable biological controls for thimbleberry, wild raspberry and other *Rubus* spp. which compete with commercial forest trees. ***Locations:*** Maritime Provinces and British Columbia. ***Methods:*** **Experimental Design** – Stands of thimbleberry, wild raspberry, and other wild *Rubus* spp. have been examined for disease over wide areas. Cultures of microorganisms were isolated from diseased tissues. Plants have been inoculated with native microorganisms in growth chambers, greenhouses, and in replicated field plots. Simultaneously, stress treatments such as clipping and defoliation have been applied. ***Results:*** Work with raspberry in the Maritime Provinces indicated few microbial pathogens with bioherbicide potential and considerable resilience after midsummer defoliation. Weak pathogens frequently isolated included the fire blight bacterium and four fungi associated with mild leaf and shoot blights (*Gnomonia rubi*, *Botrytis* sp., *Colletotrichum* sp., and *Phoma* sp.). These caused very little damage to inoculated plants. Most of the natural control occurring in wild raspberry appeared to be the result of virus diseases. The most conspicuous among the latter group was the raspberry leaf curl disease which appeared in most stands during the first year of development and caused >60% height reduction in affected plants. *Rubus* mosaic virus diseases were also noted in New Brunswick. An insect (*Elachiptera costata*) was associated with a severe blighting of young canes. Clipping of first-year growth to ground level during late June to mid-July resulted in about 50% height reduction by the end of the growing season. On thimbleberry in British Columbia, *Septoria* leaf spot, root rots associated with *Resinicium* sp. and *Naematoloma fasciculare*, and galls caused by the insect *Diastrophus kinkaidii* have been collected and are being examined with respect to biological control. Effects of sublethal doses of herbicides and manual clipping and defoliation are being studied in relation to the effects of foliar and root pathogens. ***Conclusions:*** Biological controls can only be developed with advanced technology plus better understanding of the target species and the ecosystems in which they thrive. No pathogens of *Rubus* spp. with bioherbicide potential are yet evident, but some may remain undiscovered. In wild raspberry in eastern Canada, the raspberry leaf curl virus already provides some control and means of enhancing the effectiveness of the aphid-borne virus may be found. **(PACIFIC FORESTRY CENTRE, Victoria, British Columbia.)**

Summary of Vegetation Management Activity in Forestry Canada

The objective of vegetation management is to provide a competitive advantage for desired forest tree species over other species of plants occupying the same site. There are two approaches to this: to control the growth of the undesirable competing species and to enhance the competitive ability of the crop tree species over the competing species. Combinations of these approaches may also be used.

The majority of vegetation management-related projects within Forestry Canada involve the use of herbicides, and every establishment has at least some involvement with herbicides. Glyphosate (Roundup or Vision) is the most widely used, mostly applied by a sprayer (aerially or backpack) but NoFC has tested it in the hack-and-squirt procedure. Although results are rather sketchy, it appears that glyphosate used as a spray is effective in reducing competing vegetation and is not detrimental to conifer seedlings if applied when the seedlings are in a dormant or hardened-off state. The results of use in the hack-and-squirt procedure were not revealed. Hexazinone, either as liquid (Velpar) or granular (Pronone 10G), was the second most commonly used herbicide. The largest assortment of herbicides was used in the Maritimes by both Forestry Canada-Maritimes and FPMI who have established several studies. Some of these chemicals are detrimental to the seedlings and so one must be aware of the species affected and the result desired from their use.

Some mechanical site preparation is done at every forestry centre, usually as a control or comparison with herbicides rather than as a study in itself. Hand cutting techniques are used for most small operations, although FC-M uses deep rototilling in some situations. A variety of larger implements have been used by NoFC and PFC, and a Bräcke scarifier was used by GLFC and a crusher by FPMI in New Brunswick. The heavier machinery can effectively remove competing vegetation including the root systems but often removes the topsoil and organic matter as well, creating a nutrient-poor medium into which seedlings are planted. Thus the planting site within the scarified area becomes critical. Hand cutting and mechanical shearing techniques usually remove the above-ground portion of competing plants. Depending on site conditions and competition, annual or biannual treatment may be required for a few years.

Prescribed fire as a vegetation control procedure is being examined only at PFC, and this only in the subalpine zone, even though post-logging burning is commonly practiced elsewhere in the province. Prescribed fire is effective in removing the above-ground portion of competing woody plants and makes the area easier to plant. It is too early to tell if the removal of competing vegetation is sufficient to allow seedlings to grow faster than the weeds.

A study of the timing of forest harvesting in relation to vegetation control is currently under way at PFC.

The study of biological control techniques for vegetation management is currently under way at PFC. Some work has also been done at FC-M by R.E. Wall. A variety of organisms are being examined, mostly through isolation of naturally occurring organisms. Fungi and bacteria have been identified which are deleterious to the growth of weeds. As yet insufficient work has been done to assess their efficacy.

Most submitted summaries pertain to studies currently under way so results are preliminary. Even where some results are available they mostly pertain to the immediate or short-term effect of the vegetation control technique. In order to fully examine the effectiveness of a technique for controlling competing vegetation, the study must continue at least until the seedlings reach the "free-to-grow" stage.

Even though Forestry Canada has a fairly active vegetation management research program across the nation, there are some other aspects requiring study. Some of the techniques now being tested also require testing in other situations and in different climatic regions. It is becoming increasingly important to find alternatives to the use of chemicals and prescribed burning because of environmental concerns of the public. Climatic conditions of forest land are diverse, and the variation in competing species and ecological differences in the desired tree species mean that universal techniques are unlikely. The exception might be the use of certain chemicals. The following paragraphs indicate some of the possible avenues which might be examined for vegetation control procedures, excluding those based on chemicals which are already being widely studied.

(1) Different sizes of planting stock. There are different sized plugs available, and different sized plants for bareroot planting can be grown. Use of larger plants may give a competitive edge to the tree in respect to the competing species. This must be examined for each species in the light of the economics of seedling production.

(2) Time of planting. This factor will vary with ecoclimatic subregion or site, particularly in relation to available moisture and with the use of site preparation. Timing can be viewed in relation to time of year or in terms of time after logging. In some cases a few years may elapse between forest removal and replanting.

(3) Timing of forest harvesting. The effect of operating heavy logging equipment on thawed or wet soil can be very different from that of operating it on frozen or dry soil. Under the former conditions, the churning achieved by the harvesting procedure can have a deleterious effect on the remaining vegetation, but at the same time can compact the soil making an inhospitable planting site.

(4) Forest harvesting procedures. High lead logging could be examined as an alternative to skidder logging under various conditions. Clearcutting vs. selective harvesting might be examined. Adequate regeneration of the desirable tree species may be acheived through repeated selective removal of larger trees.

(5) Mechanical procedures. There are many forms of mechanical site preparation needing further examination for effectiveness in forming a favorable planting site without degrading the site at the same time. Steepness of slope, stone size, and content of the soil will influence the type of machinery used. Cost effectiveness must also be considered as well.

(6) Prescribed burning. Fuel load and moisture conditions (often related to the amount of organic matter) at time of burn greatly influence the effect of the burn on the site. Hot burns, arising from dry fuel, reach deeper into the root systems of potential competing plants and may provide more mineral surface for planting. These fires are more difficult to control and may remove most of the soil nutrients.

(7) Biological control. Research into biological control of vegetation is a relatively new field. Organisms are needed which are specific to a particular species and which can be operationally propagated. There are public concerns about environmental impact from the application of biologically altered organisms which are just as great as those regarding the use of chemicals.

It is intended that the Vegetation Management Working Group will update these summaries annually, adding new studies as they develop and recording results as they become available. The task will be enlarged to include summaries from research by other agencies. Any suggestion for improvement in content or format would be appreciated.

Common and Scientific Names of Plants

Coniferous trees

cedar (eastern white cedar)	*Thuja occidentalis*
western red	*Thuja plicata*
Douglas-fir	*Pseudotsuga menziesii*
fir	*Abies* sp.
alpine	*Abies lasiocarpa*
balsam	*Abies balsamea*
grand	*Abies grandis*
hemlock, western	*Tsuga heterophylla*
larch	*Larix* sp.
eastern (tamarack)	*Larix laricina*
European	*Larix decidua*
western	*Larix occidentalis*
pine	*Pinus* sp.
jack	*Pinus banksiana*
lodgepole	*Pinus contorta*
ponderosa	*Pinus ponderosa*
red	*Pinus resinosa*
Scots	*Pinus sylvestris*
spruce	*Picea* sp.
black	*Picea mariana*
Engelmann	*Picea engelmannii*
Norway	*Picea abies*
red	*Picea rubens*
Sitka	*Picea sitchensis*
white	*Picea glauca*

Deciduous trees

alder, red	*Alnus rubra*
ash	*Fraxinus* sp.
black	*Fraxinus nigra*
white	*Fraxinus americana*
aspen (trembling aspen)	*Populus tremuloides*
largetooth	*Populus grandidentata*
beech (American beech)	*Fagus grandifolia*
birch	*Betula* sp.
paper/white	*Betula papyrifera*
yellow	*B. alleghaniensis (B.lutea)*
cottonwood, black	*Populus trichocarpa*
maple	*Acer* sp.
bigleaf	*Acer macrophyllum*
Manitoba	*Acer negundo*
mountain	*Acer spicatum*
red	*Acer rubrum*
striped	*Acer pensylvanicum*
sugar	*Acer saccharum*
oak, red	*Quercus rubra*
poplar, balsam	*Populus balsamifera*

Shrubs

alders	*Alnus* sp.
azalea, false	*Menziesia ferruginea*
blueberries	*Vaccinium* sp.
blueberry, black	*Vaccinium membranaceum*
cherry, pin	*Prunus pensylvanica*
elderberry	*Sambucus* sp.
hazel	*Corylus* sp.
beaked	*Corylus rostrata*
hobblebush	*Viburnum alnifolium*
huckleberry, red	*Vaccinium parvifolium*
raspberry	*Rubus* sp.
red	*Rubus idaeus*
wild	*Rubus* sp.
rhododendron, white-flowered	*Rhododendron albiflorum*
salal	*Gaultheria shallon*
salmonberry	*Rubus spectabilis*
sheep-laurel	*Kalmia angustifolia*
thimbleberry	*Rubus parviflorus*

Herbs

aster, acuminate	*Aster acuminatus*
bracken	*Pteridium aquilinum*
fern, deer	*Blechnum spicant*
lady	*Athyrium filix-femina*
sword	*Polystichum munitum*
fireweed	*Epilobium angustifolium*
grass, reed	*Calamagrostis* sp.
strawberry	*Fragaria* sp.